Sepam™ Series 20 Protective Relays

User's Manual

Instruction Bulletin

63230-216-208C1

Retain for future use.

Merlin Gerin
Square D
Telemecanique

Schneider Electric

Safety Instructions

Safety symbols and messages

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service or maintain it. The following special messages may appear throughout this bulletin or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

ANSI symbol IEC symbol

Risk of electric shock

The addition of either symbol to a “Danger” or “Warning” safety label on a device indicates that an electrical hazard exists, which will result in death or personal injury if the instructions are not followed.

Safety alert

This is the safety alert symbol. It is used to alert you to potential personal injury hazards and prompt you to consult the manual. Obey all safety instructions that follow this symbol in the manual to avoid possible injury or death.

Safety messages

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death, serious injury or property damage.

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **could result in** death, serious injury or property damage.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, minor or moderate injury or property damage.

Important notes

Restricted liability

Electrical equipment should be serviced and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this manual. This document is not intended as an instruction manual for untrained persons.

Device operation

The user is responsible for checking that the rated characteristics of the device are suitable for its application. The user is responsible for reading and following the device’s operating and installation instructions before attempting to commission or maintain it. Failure to follow these instructions can affect device operation and constitute a hazard for people and property.

Protective grounding

The user is responsible for compliance with all the existing international and national electrical codes concerning protective grounding of any device.

FCC Notice

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. This Class A digital apparatus complies with Canadian ICES-003.

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Overview of PowerLogic® Sepam™ Protective Relays

The PowerLogic® Sepam™ range of protective relays is designed for protection applications on medium-voltage public and industrial distribution networks.

The Sepam product range consists of three series of relays:

- *Sepam Series 20, for simple applications*
- *Sepam Series 40, for demanding applications*
- *Sepam Series 80, for custom applications*

All information relating to the Sepam range can be found in the following documents:

- *Sepam Catalog, 63230-216-238*
- *Sepam Series 20 User's Manual, 63230-216-208*
- *Sepam Series 40 User's Manual, 63230-216-219*
- *Sepam Series 80 Reference Manual, 63230-216-230*
- *Sepam Series 80 Modbus Communication User's Manual, 63230-216-231*
- *Sepam series 80 Operation Manual, 63230-216-229*
- *Sepam DNP3 Communication User's Manual, 63230-216-236*
- *Sepam IEC 60870-5-103 Communication User's Manual, 63230-216-237*

Sepam Series 20

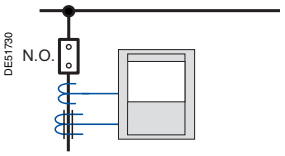
For Simple Applications

PE50465

Characteristics

- 10 Logic Inputs
- 8 Relay Outputs
- 1 Communication Port
- 8 Temperature Sensor Inputs

DE51730



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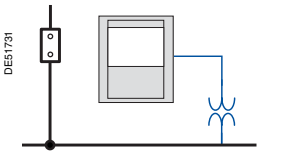

Sepam Series 40

For Demanding Applications

PE50465

Characteristics

- 10 Logic Inputs
- 8 Relay Outputs
- Logic Equation Editor
- 1 Communication Port
- 16 Temperature Sensor Inputs

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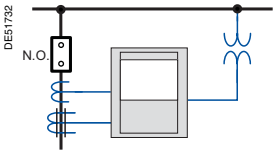

Sepam Series 80

For Custom Applications

PE50463

PE50464

Characteristics

- 42 Logic Inputs
- 23 Relay Outputs
- Logic Equation Editor
- 2 Communication Ports for Multimaster or Redundant Architecture
- 16 Temperature Sensor Inputs
- Removable Memory Cartridge with Parameters and Settings for Quick Return to Service After Replacement
- Battery for Storing Logs and Recording Data
- Mimic-Based User-Machine Interface for Local Control of the Device in Complete Safety
- Optional Logipam Programming Software, for Programming Dedicated Functions

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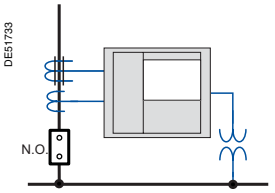

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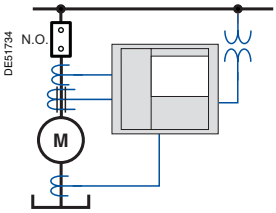

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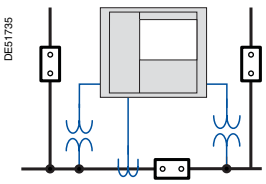

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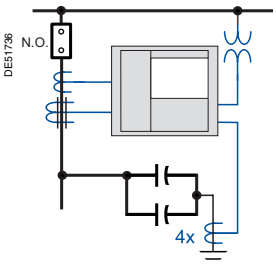

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Overview of PowerLogic® Sepam™ Protective Relays

Protection		Applications					
Standard	**Specific**	**Substation**	**Bus**	**Transformer**	**Motor**	**Generator**	**Capacitor**
Current Protection		**S20**		**T20**	**M20**		
	Breaker Failure	**S23**		**T23**			
Voltage and Frequency Protection			**B21**				
	Disconnection (df/dt)		**B22**				
Current, Voltage and Frequency Protection		**S40**		**T40**		**G40**	
	Directional Ground Fault	**S41**			**M41**		
	Directional Ground Fault and Phase Overcurrent	**S42**		**T42**			
Current, Voltage and Frequency Protection		**S80**	**B80**				
	Directional Ground Fault	**S81**		**T81**	**M81**		
	Directional Ground Fault and Phase Overcurrent	**S82**		**T82**		**G82**	
	Disconnection (df/dt)	**S84**					
Current, Voltage and Frequency Protection	Transformer or Machine-Transformer Unit Differential			**T87**	**M88**	**G88**	
	Machine Differential				**M87**	**G87**	
Current, Voltage and Frequency Protection	Voltage and Frequency Protection for 2 Sets of Busbars		**B83**				
Current, Voltage and Frequency Protection	Capacitor Bank Unbalance						**C86**

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Overview of Sepam™ Series 20 Protective Relays

PE50297

Sepam is a modular solution.

The Sepam™ Series 20 family of protection and metering units is designed for the operation of machines and electrical distribution networks of industrial installations and utility substations for all levels of voltage.

The Sepam Series 20 family consists of simple, high-performing solutions, suited to demanding applications that call for current and voltage metering.

Sepam Series 20 Selection Guide, by Application

Selection Criteria	Series 20			
Metering	I	I	V	V
Specific Protection Functions	Normal Operation	Breaker Failure	Normal Operation	Disconnection (df/dt)
Applications				
Substation	S20	S23		
Transformer	T20	T23		
Motor	M20			
Bus			B21	B22

PE50298

Sepam with basic UMI and with fixed advanced UMI.

Main Functions

Protection

- Overcurrent and ground fault protection with adjustable time reset
- Overcurrent and ground fault protection with logically controlled switching between setting groups
- Ground fault protection insensitivity to transformer switching
- Detection of phase unbalance
- RMS thermal protection that accounts for external operating temperature and ventilation operating rates
- Rate of change of frequency protection (df/dt), for a fast and reliable disconnection

Communication

Sepam relays can be connected to a supervision communication network (S-LAN) based on the following communication protocols:

- Modbus RTU
- DNP3
- IEC 60870-5-103

Also, Sepam relays can manage equipment from a centralized remote monitoring system since all necessary data are available via the communication port:

- **Reading**: all measurements, alarms, protection settings, etc.
- **Writing**: breaking device remote control commands, etc.

Diagnosis

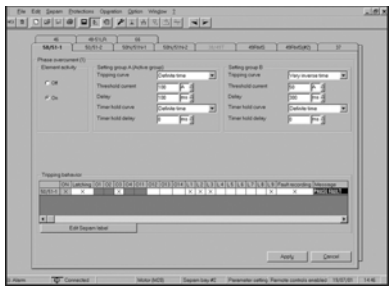
3 types of diagnosis data are available for improved operation:

- **Network and Machine Diagnosis**: Tripping current, unbalance ratio, disturbance recording
- **Switchgear Diagnosis**: Cumulative breaking current, operating time
- **Diagnosis of the Protection Unit and Additional Modules**: Continuous self-testing, watchdog

Control and monitoring

The circuit breaker program logic is ready-to-use, requiring no auxiliary relays or additional wiring.

PE50593



Example of an SFT2841 software screen.

User-Machine Interface

Two levels of User-Machine Interface (UMI) are available to suit any application:

- **Basic UMI:**

An economical solution for installations that do not require local operation (i.e., that are run via a remote monitoring and control system)

- **Fixed or Remote Advanced UMI:**

A graphic LCD display and 9-key keypad are used to display the measurement and diagnosis values, alarm and operating messages and to provide access to protection and parameter setting values for installations that are operated locally

Setting and operating software

The **SFT2841** PC software tool gives access to all the Sepam relay functions, with the convenience of a Windows® environment.

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Selection Table

		Substation		Transformer		Motor	Bus	
Protection	**ANSI Code**	**S20**	**S23**	**T20**	**T23**	**M20**	**B21 (3)**	**B22**
Phase Overcurrent	50/51	4	4	4	4	4		
Ground Fault, Sensitive Ground Fault	50N/51N 50G/51G	4	4	4	4	4		
Breaker Failure	50BF		1		1			
Negative-Sequence/Current Unbalance	46	1	1	1	1	1		
Thermal Overload	49RMS			2	2	2		
Phase Undercurrent	37					1		
Locked Rotor, Excessive Starting Time	48/51LR/14					1		
Starts per Hour	66					1		
Positive-Sequence Undervoltage	27D/47						2	2
Remanent Undervoltage	27R						1	1
Phase-to-Phase Undervoltage	27						2	2
Phase-to-Neutral Undervoltage	27S						1	1
Phase-to-Phase Overvoltage	59						2	2
Neutral Voltage Displacement	59N						2	2
Overfrequency	81H						1	1
Underfrequency	81L						2	2
Rate of Change of Frequency (df/dt)	81R							1
Recloser (4 Shots)	79	□	□					
Thermostat/Buchholz	26/63			□	□			
Temperature Monitoring (8 Sensors, 2 Set Points per Sensor)	38/49T			□	□	□		
Metering								
Phase Current — RMS (Ia, Ib, Ic), Residual Current (Ir)		■	■	■	■	■		
Demand Current (Ia, Ib, Ic), Peak Demand Current (Iamax, Ibmax, Icmax)		■	■	■	■	■		
Voltage (Vab, Vbc, Vca, Van, Vbn, Vcn), Residual Voltage (Vr)							■	■
Positive-Sequence Voltage (V1)							■	■
Frequency							■	■
Temperature				□	□	□		
Network and Machine Diagnosis								
Tripping Current (TripIa, TripIb, TripIc, TripIr)		■	■	■	■	■		
Unbalance Ratio/Negative-Sequence Current (I2)		■	■	■	■	■		
Disturbance Recording		■	■	■	■	■	■	■
Thermal Capacity Used				■	■	■		
Remaining Operating Time Before Overload Tripping				■	■	■		
Waiting Time After Overload Tripping				■	■	■		
Running Hours Counter/Operating Time				■	■	■		
Starting Current and Time						■		
Block Start Time, Number of Starts Before Blocking						■		
Switchgear Diagnosis								
Cumulative Breaking Current		■	■	■	■	■		
Trip Circuit Supervision		□	□	□	□	□	□	□
Number of Operations, Operating Time, Charging Time		□	□	□	□	□		
Control and Monitoring	**ANSI Code**							
Circuit Breaker/Contactor Control (1)	94/69	□	□	□	□	□	□	□
Latching/Acknowledgment	86	■	■	■	■	■	■	■
Zone Selective Interlocking	68	□	□	□	□	□		
Switching of Groups of Settings		■(2)	■(2)	■(2)	■(2)	■(2)		
Block Protection of 50N/51N by an Input			□					
Annunciation	30	■	■	■	■	■	■	■
Additional Modules								
8 Temperature Sensor Inputs - MET1482 Module				□	□	□		
1 Low Level Analog Output - MSA141 Module		□	□	□	□	□	□	□
Logic Inputs/Outputs — MES114/MES114E/MES114F Module (10I/4O)		□	□	□	□	□	□	□
Communication Interface — ACE9492, ACE959, ACE937, ACE969TP, or ACE969FO		□	□	□	□	□	□	□

■ Standard

□ According to parameter setting and MES114/MES114E/MES114F, MET1482, MSA141input/output option modules, and ACE9492, ACE959, ACE937, ACE969TP, ACE969FO communications option modules

(1) *For normally open or normally closed trip contact.*

(2) *Exclusive choice between zone selective interlocking and switching from one 2-relay group of settings to another 2-relay group*

(3) *Performs Sepam B20 functions*

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Technical Characteristics

Weight					
Minimum Weight (Sepam™ with Basic UMI and without MES114)	2.6 lb (1.2 kg)				
Maximum Weight (Sepam with Advanced UMI and MES114)	3.7 lb (1.7 kg)				
Analog Inputs					
Current Transformer	Input Impedance	< 0.02 Ω			
1 A or 5 A CT (with CCA630 or CCA634)	Burden	< 0.02 VA at 1 A			
1 A to 6250 A Ratings		< 0.5 VA at 5 A			
	Rated Thermal Withstand	4 IN			
	1-Second Overload	100 IN			
Voltage Transformer	Input Impedance	> 100 kΩ			
220 V to 250 kV Ratings	Input Voltage	100 to 230/√3 V			
	Rated Thermal Withstand	240 V			
	1-Second Overload	480 V			
Temperature Sensor Input (MET1482 Module)					
Type of Sensor		Pt 100		Ni 100/120	
Isolation from Ground		None		None	
Current Injected in Sensor		4 mA		4 mA	
Maximum Distance between Sensor and Module		1 km (0.62 mi)			
Logic Inputs		**MES114**	**MES114E**		**MES114F**
Voltage		24–250 V DC	110–125 V DC	110 V AC	220–250 V DC	220–240 V AC
Range		19.2–275 V DC	88–150 V DC	88–132 V AC	176–275 V DC	176–264 V AC
Frequency		—	—	47–63 Hz	—	47 to 63 Hz
Typical Burden		3 mA	3 mA	3 mA	3 mA	3 mA
Typical Switching Threshold		14 V DC	82 V DC	58 V AC	154 V DC	120 V AC
Input Limit Voltage	At State 1	⩾ 19 V DC	⩾ 88 V DC	⩾ 88 V AC	⩾ 176 V DC	⩾ 176 V AC
	At State 0	⩽ 6 V DC	⩽ 75 V DC	⩽ 22 V AC	⩽ 137 V DC	⩽ 48 V AC
Isolation of inputs in relation to other isolated groups		Enhanced	Enhanced	Enhanced	Enhanced	Enhanced
Relay Outputs						
Control Relay Outputs (O1, O2, O11 Contacts) (2)						
Voltage	DC	24/48 V DC	125 V DC	250 V DC		
	AC (47.5 to 63 Hz)	—	—	—	100–240 V AC	
Continuous Current		8 A	8 A	8 A	8 A	
Breaking Capacity	Resistive Load	8/4 A	0.7 A	0.3 A		
	L/R Load < 20 ms	6/2 A	0.5 A	0.2 A		
	L/R Load < 40 ms	4/1 A	0.2 A	0.1 A		
	Resistive Load	—	—	—	8 A	
	p.f. Load > 0.3	—	—	—	5 A	
Making Capacity		< 30 A for 200 ms				
Isolation of Outputs in Relation to Other Isolated Groups		Enhanced				
Annunciation Relay Outputs (O3, O4, O12, O13, O14 Contacts)						
Voltage	DC	24/48 V DC	125 V DC	250 V DC		
	AC (47.5–63 Hz)	—	—	—	100–240 V AC	
Continuous Current		2 A	2 A	2 A	2 A	
Breaking Capacity	L/R Load < 20 ms	2/1 A	0.5 A	0.15 A		
	p.f. Load > 0.3	—	—	—	1 A	
Isolation of Outputs in Relation to Other Isolated Groups		Enhanced				
Power Supply						
Voltage		24/250 V DC		110/240 V AC		
Range		-20% +10%		-20% +10% (47.5–63 Hz)		
Deactivated Burden (1)		< 4.5 W		< 9 VA		
Maximum Burden (1)		< 8 W		< 15 VA		
Inrush Current		< 10 A for 10 ms < 28 A for 100 µs		< 15 A for First Cycle		
Acceptable Momentary Outages		10 ms		10 ms		
Analog Output (MSA141 Module)						
Current		4–20 mA, 0–20 mA, 0–10 mA				
Load Impedance		< 600 Ω (Including Wiring)				
Accuracy		0.50%				

(1)*According to configuration*

(2) *Relay outputs (O1, O2, O11 contact) comply with clause 6.7 of standard C37.90, (30 A, 200 ms, 2000 operations).*

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Environmental Characteristics

Electromagnetic Compatibility	Standard	Level/Class	Value
Emission Tests			
Disturbing Field Emission	IEC 60255-25		
	EN 55022	A	
Conducted Disturbance Emission	IEC 60255-25		
	EN 55022	B	
Immunity Tests – Radiated Disturbances			
Immunity to Radiated Felds	IEC 60255-22-3		10 V/m; 80 MHz to 1 GHz
	IEC 61000-4-3	III	10 V/m; 80 MHz to 2 GHz
	ANSI C37.90.2		35 V/m; 25 MHz to1 GHz
Electrostatic Discharge	IEC 60255-22-2		8 kV Air; 6 kV Contact
	ANSI C37.90.3		8 kV Air; 4 kV Contact
Immunity to Magnetic Fields at Network Frequency	IEC 61000-4-8	4	30 (Continuous) to 300 (1-3 s) A/m
Immunity Tests – Conducted Disturbances			
Immunity to Conducted RF Disturbances	IEC 60255-6-5		10 V
Fast Transient Bursts	IEC 60255-22-4	A or B	4 kV; 2.5 kHz/2 kV; 5 kHz
	IEC 61000-4-4	IV	4 kV; 2.5 kHz
	ANSI C37.90.1		4 kV; 2.5 kHz
1 MHz Damped Oscillating Wave	IEC 60255-22-1	III	2.5 kV MC; 1 kV MD
	ANSI C37.90.1		2.5 kV MC and MD
100 KHz Damped Oscillating Wave	IEC 61000-4-12		2.5 kV MC; 1 kV MD
Surges	IEC 61000-4-5	III	2 kV MC; 1 kV MD
Voltage Interruptions	IEC 60255-11		Series 20: 100%, 10 ms Series 40: 100%, 20 ms
Mechanical Durability	**Standard**	**Level/Class**	**Value**
Energized			
Vibrations	IEC 60255-21-1	2	1 Gn; 10–150 Hz
	IEC 60068-6-5	Fc	2–13.2 Hz; a = ±0.039 in (±1 mm)
Shocks	IEC 60255-21-2	2	10 Gn/11 ms
Earthquakes	IEC 60255-21-3	2	2 Gn (Horizontal Axes)
			1 Gn (Vertical Axes)
De-Energized			
Vibrations	IEC 60255-21-1	2	2 Gn; 10–150 Hz
Shocks	IEC 60255-21-2	2	30 Gn/11 ms
Bumps	IEC 60255-21-2	2	20 Gn/16 ms
Environmental Tolerances	**Standard**	**Level/Class**	**Value**
For Operation			
Exposure to Cold	IEC 60068-2-1	Series 20: Ab	-13° F (-25° C)
Exposure to Dry Heat	IEC 60068-2-2	Series 20: Bb	158° F (70° C)
Continuous Exposure to Damp Heat	IEC 60068-2-3	Ca	10 days; 93% RH; 104° F (40° C)
Temperature Variation with Specified Variation Rate	IEC 60068-2-14	Nb	-13° to +158° F (–25° to +70° C) 5° C/min
Salt Mist	IEC 60068-2-52	Kb/2	
Influence of Corrosion/2 Gas Test	IEC 60068-2-60	C	21 days; 75% RH; 77° F (25° C); 0.5 ppm H_2S; 1 ppm SO_2
Influence of Corrosion/4 Gas Test	IEC 60068-2-60		21 days; 75% RH; 77° F (25° C); 0.01 ppm H_2S; 0.2 ppm SO_2 ; 0.02 ppm NO_2; ; 0.01 ppm Cl_2
For Storage (3)			
Exposure to Cold	IEC 60068-2-1	Ab	-13° F (-25° C)
Exposure to Dry Heat	IEC 60068-2-2	Bb	158° F (70° C)
Continuous Exposure to Damp Heat	IEC 60068-2-3	Ca	56 days; 93% RH; 104° F (40° C)
Safety	**Standard**	**Level/Class**	**Value**
Enclosure Safety Tests			
Front Panel Tightness	IEC 60529	IP52	Other Panels Closed, Except for Rear Panel IP20
	NEMA	Type 12, Gasket Integrated or Supplied Acc. to Model	
Fire Wthstand	IEC 60695-2-11		1200° F (650° C) with Glow Wire
Electrical Safety Tests			
1.2/50µs Impulse Wave	IEC 60255-5		5 kV (1)
Power Frequency Dielectric Withstand	IEC 60255-5		2 kV 1 min (2)
	ANSI C37.90		1 kV 1 min (Indication Output)
			1.5 kV 1 min (Control Output)
Certification			
CE	Harmonized Standard: EN 50263	European Directives: ■ 89/336/EEC Electromagnetic Compatibility Directive (EMC) □ 92/31/EEC Amendment □ 93/68/EEC Amendment ■ 73/23/EEC Low Voltage Directive □ 93/68/EEC Amendment	
UL - c UL us	UL508 - CSA C22.2 no. 14-95		File E212533
CSA	CSA C22.2 no. 14-95/no. 94-M91/no. 0.17-00		File 210625

***(1)** Except for communication: 3 kV in common mode and 1 kV in differential mode*
***(2)** Except for communication: 1 kVrms*
***(3)** Sepam™ must be stored in its original packing.*

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General Settings

These values define the settings of the sensors connected to PowerLogic® Sepam™ relays and determine the performance of the metering and protection functions used. They are accessed via the *General Characteristics* tab in the SFT2841 setting software.

General Settings		Selection	Setting Range
IN	Rated Phase Current (Sensor Primary Current)	2 or 3 CT 1 A / 5 A	1–6250 A
		3 LPCTs	25–3150 A (1)
I_B	Base Current, According to Equipment Power Rating		0.4–1.3 IN
INr	Rated Residual Current (2)	Sum of 3 Phase Currents	See IN rated phase current
		CSH120 or CSH200 Zero Sequence CT	2–20 A rating
		1 A/5 A CT	1–6250 A
		Zero Zequence CT + ACE990 (the Zero Sequence CT Ratio 1/n must be such that $50 \leqslant n \leqslant 1500$)	According to Current Monitored and Use of ACE990
$V_{LL}p$	Rated Primary Phase-to-Phase Voltage (Vnp: Rated Primary Phase-to-Neutral Voltage $V_{Ln}p = V_{LL}p/\sqrt{3}$)		220 V to 250 kV
$V_{LL}s$	Rated Secondary Phase-to-Phase Voltage	3 VTs: Van, Vbn, Vcn	100, 110, 115, 120, 200, 240 V
		2 VTs: Vab, Vbc	100, 110, 115, 120 V
		1 VT: Van	100, 110, 115, 120 V
Vsr	Secondary Zero Sequence Voltage for Primary Zero Sequence Voltage ($V_{LL}p/\sqrt{3}$)		$V_{LL}s/3$ or $V_{LL}s/\sqrt{3}$
	Rated Frequency		50 Hz or 60 Hz
	Integration Period (For Demand Current and Peak Demand Current and Power)		5, 10, 15, 30, 60 min

(1) *IN values for LPCT, in Amps: 25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000, 3150.*

(1) *INr should be thought of as a relay input port for ground fault protection. This port can accept residually connected phase CT and therefore measure positive, negative and zero sequence components. This port can also accept a zero sequence CT which measures only true zero sequence (no positive or negative sequence). So the port name INr is just that a port name. What kind of current (positive, negative or zero sequence) depends on the type of CT used.*

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Characteristics

Functions		Measurement Range	Accuracy (1)	MSA141	Saving
Metering					
Phase Current		0.1–40 IN (2)	±1%	■	
Residual Current	Calculated	0.1–40 IN	±1%	■	
	Measured	0.1–20 Inr	±1%	■	
Demand Current		0.1–40 IN	±1%		
Peak Demand Current		0.1–40 IN	±1%		□
Phase-to-Phase Voltage		0.05–1.2 V_{LL}p	±1%	■	
Phase-to-Neutral Voltage		0.05–1.2 V_{Ln}p	±1%	■	
Residual Voltage		0.015–3 V_{Ln}p	±1%		
Positive Sequence Voltage		0.05–1.2 V_{Ln}p	±5%		
Frequency Sepam™ Series 20 Relay		50 ±5 Hz or 60 ±5 Hz	±0.05 Hz	■	
Temperature		-22 to +392 °F (-30 to +200 °C)	±1°C from 20–140°C	■	
Network Diagnosis Assistance					
Phase Tripping Current		0.1–40 IN	±5%		□
Ground Fault Tripping Current		0.1–20 Inr	±5%		□
Negative Sequence/Unbalance		10–500% of I_B	±2%		
Disturbance Recording					
Machine Operating Assistance					
Thermal Capacity Used		0–800% (100% for I Phase = I_B)	±1%	■	□
Remaining Operating Time Before Overload Tripping		0–999 min	±1 min		
Waiting Time After Overload Tripping		0–999 min	±1 min		
Running Hours Counter/Operating Time		0–65535 hrs	±1% or ±0.5 hrs		□
Starting Current		1.2 I_B to 24 IN	±5%		□
Starting Time		0–300 s	±300 ms		□
Number of Starts Before Blocking		0–60	1		
Block Start Time		0–360 min	±1 min		
Switchgear Diagnosis Assistance					
Cumulative Breaking Current		0–65535 kA^2	±10%		□
Number of Operations		0–4.10^9	1		□
Operating Time		20–100 ms	±1 ms		□
Charging Time		1–20 s	±0.5 s		□

■ *Available on MSA141 analog output module, according to setup.*
□ *Saved in the event of auxiliary supply outage.*
(1) *Typical accuracy, see details on subsequent pages.*
(2) *Measurement up to 0.02 IN for information purposes.*

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Phase Current & Residual Current

Phase Current

Operation

This function gives the RMS value of the phase currents
(based on RMS current measurement, accounting for up to the 17th harmonic):

- Ia: phase a current
- Ib: phase b current
- Ic: phase c current

Readout

The measurements can be accessed via:

- The display of a Sepam™ relay with an advanced user-machine interface (UMI), by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link
- An analog converter with the MSA141 option

Characteristics

Measurement Range	0.1–1.5 I_N (1)
Unit	A or kA
Accuracy	typically ±1% (2) ±2% from 0.3–1.5 I_N ±5% if < 0.3 I_N
Display Format (3)	3 Significant Digits
Resolution	0.1 A or 1 Digit
Refresh Interval	1 s (Typical)

(1) *I_N rated current set in the general settings.*
(2) *At I_N, in reference conditions (IEC 60255-6).*
(3) *Display of values: 0.02–40 I_N.*

Residual Current

Operation

This operation gives the RMS value of the residual current Ir
(based on measurement of the fundamental component).

Note : *I_{Nr} should be thought of as a relay input port for ground fault protection. This port can accept residually connected phase CT and therefore measure positive, negative and zero sequence components. This port can also accept a zero sequence CT which measures only true zero sequence (no positive or negative sequence). So the port name I_{Nr} is just that a port name. What kind of current (positive, negative or zero sequence) depends on the type of CT used.*

Readout

The measurements can be accessed via:

- The display of a Sepam relay with an advanced UMI, by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link
- An analog converter with the MSA141 option

Characteristics

Measurement Range		
Connection to 3 Phase CT		0.1–1.5 I_{Nr} (1)
Connection to 1 CT		0.1–1.5 I_{Nr} (1)
Connection to Zero Sequence CT with ACE990		0.1–1.5 I_{Nr} (1)
Connection to CSH Residual Current Sensor	2 A Rating	0.2–3 A
	20 A Rating	2–30 A
Unit		A or kA
Accuracy (2)		Typically ±1% at I_{Nr} ±2% from 0.3–1.5 I_{Nr} ±5% if < 0.3 I_{Nr}
Display Format		3 Significant Digits
Resolution		0.1 A or 1 Digit

(1) *I_{Nr} rated current set in the general settings.*
(2) *In reference conditions (IEC 60255-6), excluding sensor accuracy.*

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Average Current & Peak Demand Current

Average Current & Peak Demand Current

Operation

This function gives:

- The average phase current (RMS) for each phase, for each integration interval (1)
- The greatest average RMS current value for each phase, since the last reset

***(1)** The values are refreshed after each "integration interval" that can be set from 5–60 min.*

Readout

The measurements can be accessed via:

- The display of a Sepam™ relay with an advanced user-machine interface (UMI), by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link

Reset to zero by:

- Pressing the clear key on the display when a peak demand current is displayed
- Using the *Clear* command in the SFT2841 software
- Using the remote control command *TC6* with the communication link

Characteristics

Measurement Range	0.1–1.5 In (2)
Unit	A or kA
Accuracy	Typically ±1% (3) ±2% from 0.3–1.5 In ±5% if < 0.3 In
Display Format (4)	3 Significant Digits
Resolution	0.1 A or 1 Digit
Integration Interval	5, 10, 15, 30, 60 min

***(2)** In rated current set in the general settings.*
***(3)** at In, in reference conditions (IEC 60255-6).*
***(4)** Display of values: 0.02–40 In.*

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Phase-to-Phase Voltage & Phase-to-Neutral Voltage

Phase-to-Phase Voltage

Operation

This function gives the phase (RMS) value of the 50 or 60 Hz component of the phase-to-phase voltages (Vab, Vbc, Vca), according to voltage sensor connections (based on the measurement of the fundamental component):

- Vab: Voltage between phases a and b
- Vbc: Voltage between phases b and c
- Vca: Voltage between phases c and a

Readout

The measurements can be accessed via:

- The display of a Sepam™ relay with an advanced user-machine interface (UMI), by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link
- An analog converter with the MSA141 option

Characteristics

Measurement Range	0.05–1.2 $V_{LL}p$ (1)
Unit	V or kV
Accuracy (2)	±1% from 0.5–1.2 $V_{LL}p$ ±2% from 0,05–0.5 $V_{LL}p$
Display Format	3 Significant Digits
Resolution	1 V or 1 Digit
Refresh Interval	1 s (Typical)

(1) *$V_{LL}N$ nominal rating set in the general settings.*
(2) *At $V_{LL}N$, in reference conditions (IEC 60255-6).*

Phase-to-Neutral Voltage

Operation

This function gives the RMS value of the 50 or 60 Hz component of the phase-to-neutral voltages
(based on the measurement of the fundamental component):

- Van: Phase a phase-to-neutral voltage
- Vbn: Phase b phase-to-neutral voltage
- Vcn: Phase c phase-to-neutral voltage

Readout

The measurements can be accessed via:

- The display of a Sepam relay with an advanced UMI, by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link
- An analog converter with the MSA141 option

Characteristics

Measurement Range	0.05–1.2 $V_{Ln}p$ (1)
Unit	V or kV
Accuracy (2)	±1% from 0.5–1.2 $V_{Ln}p$ ±2% from 0.05–0.5 $V_{Ln}p$
Display Format	3 Significant Digits
Resolution	1 V or 1 Digit
Refresh Interval	1 s (Typical)

(1) *$V_{Ln}p$: primary rated phase-to-neutral voltage ($V_{Ln}p = V_{LL}p/\sqrt{3}$).*
(2) *At $V_{Ln}p$ in reference conditions (IEC 60255-6).*

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Residual Voltage & Positive Sequence Voltage

Residual Voltage

Operation

This function gives the value of the residual voltage (Vr).

Vr is measured (based on the measurement of the fundamental component):
- By taking the internal sum of the 3 phase voltages (Vr = (Van + Vbn + Vcn))
- By an open wye/delta VT

Note : *Sometimes referred to as a wye broken delta.*

Readout

The measurement can be accessed via:
- The display of a Sepam™ relay with an advanced user-machine interface (UMI), by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link

Characteristics

Measurement Range	0.015–3 $V_{Ln}p$ (1)
Unit	V or kV
Accuracy	±1% from 0.5–3 $V_{Ln}p$ ±2% from 0.05–0.5 $V_{Ln}p$ ±5% from 0.015–0.05 $V_{Ln}p$
Display Format	3 Significant Digits
Resolution	1 V or 1 Digit
Refresh Interval	1 s (Typical)

(1) *$V_{Ln}p$: primary rated phase-to-neutral voltage ($V_{Ln}p = V_{LL}p/\sqrt{3}$).*

Positive Sequence Voltage

Operation

This function gives the calculated value of the positive sequence voltage (V1).

Readout

The measurement can be accessed via:
- The display of a Sepam relay with an advanced UMI, by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link

Characteristics

Measurement Range	0.05–1.2 $V_{Ln}p$ (1)
Unit	V or kV
Accuracy	±2% at $V_{Ln}p$
Display Format	3 Significant Digits
Resolution	1 V or 1 Digit
Refresh Interval	1 s (Typical)

(1) *$V_{Ln}p$: primary rated phase-to-neutral voltage ($V_{Ln}p = V_{LL}p/\sqrt{3}$).*

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Frequency & Temperature

Frequency

Operation

This function gives the frequency value, measured via the following:
- Based on Vab, if only one phase-to-phase voltage is connected to the Sepam™ relay
- Based on positive sequence voltage, if the Sepam relay includes Vab and Vbc measurements

Frequency is not measured if:
- The voltage Vab or positive sequence voltage V1 is less than 40% of $V_{LL}N$
- The frequency is outside the measurement range

Readout

The measurement can be accessed via:
- The display of a Sepam relay with an advanced user-machine interface (UMI), by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link
- An analog converter with the MSA141 option

Characteristics

Rated Frequency		50 Hz or 60 Hz
Range	50 Hz	45–55 Hz
	60 Hz	55–65 Hz
Accuracy (1)		±0.05 Hz
Display Format		3 Significant Digits
Resolution		0.01 Hz or 1 Digit
Refresh Interval		1 s (Typical)

(1) *At $V_{LL}p$ in reference conditions (IEC 60255-6).*

Temperature

Operation

This function gives the temperature value measured by resistance temperature detectors (RTDs):
- Platinum Pt100 100 Ω (at 32 °F or 0 °C), in accordance with the IEC 60751 and DIN 43760 standards
- Nickel 100 Ω or 120 Ω (at 32 °F or 0 °C)

Each RTD channel gives one measurement:
- tx = RTD x temperature

The function also indicates RTD faults:
- RTD disconnected (tx > 401° F or 205° C)
- RTD shorted (tx < -31° F or -35° C)

Note : *In the event of a fault, display of the value is blocked and the associated monitoring function generates a maintenance alarm.*

Readout

The measurement can be accessed via:
- The display of a Sepam relay with an advanced UMI, by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link
- An analog converter with the MSA141 option

Characteristics

Range	-22°F to +392°F (-30°C to +200°C)
Accuracy (1)	±4.24°F (2°F) ±2.12°F (1°C) from 68–284°F
Resolution	1°F (1°C)
Refresh Interval	5 s (Typical)

(1) *At $V_{LL}p$ in reference conditions (IEC 60255-6).*

Note : *The accuracy derating depends on the wiring. For more information, see* MET1482 Temperature Sensor Module *on page 151*.

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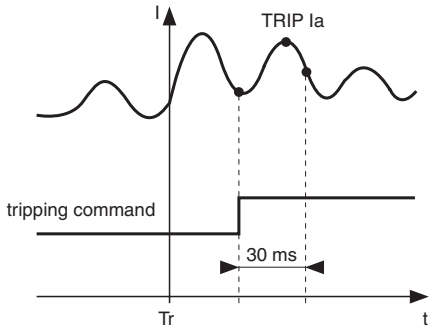
Tripping Current & Negative Sequence/Unbalance



Tripping Current

Operation

This function gives the RMS value of currents at the time of the last trip (based on the fundamental component):

- TRIP Ia: Phase a current
- TRIP Ib: Phase b current
- TRIP Ic: Phase c current
- TRIP Ir: Residual current

This measurement is defined as the maximum RMS value measured during a 30 ms interval after the activation of the tripping contact on output O1. The tripping current values are saved in the event of a power failure.

Readout

The measurements can be accessed via:

- The display of a Sepam™ relay with an advanced user-machine interface (UMI), by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link

Characteristics

Measurement Range	Phase Current 0.1–40 I_N (1)
Residual Current	0.1–20 I_{Nr}(1)
Unit	A or kA
Accuracy	±5% ±1 Digit
Display Format	3 Significant Digits
Resolution	0.1 A or 1 Digit

(1) *I_N/I_{Nr} rated current set in the general settings.*

Negative Sequence/Unbalance

Operation

This function gives the negative sequence component ($T = I2/I_B$).

The negative sequence current is based on the phase currents:

- 3 Phases

$$\vec{I2} = \frac{1}{3} \times (\vec{Ia} + x^2\vec{Ib} + x\vec{Ic})$$

with $x = e^{j\frac{2\pi}{3}}$

- 2 Phases

$$\left|\vec{I2}\right| = \frac{1}{\sqrt{3}} \times \left|\vec{Ia} - x^2\vec{Ic}\right|$$

with $x = e^{j\frac{2\pi}{3}}$

Note : *These two formulas are equivalent when there is no ground fault.*

Readout

The measurements can be accessed via:

- The display of a Sepam relay with an advanced UMI, by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link

Characteristics

Measurement Range	10–500
Unit	% I_B
Accuracy	±2%
Display Format	3 Significant Digits
Resolution	1%
Refresh Interval	1 s (Typical)

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Disturbance Recording

Operation

This function is used to record analog signals and logical states. The Storage function is initiated, based on parameter settings, by a triggering event (see *Disturbance Recording Triggering* on page 80). Recording begins before the triggering event, and continues afterward.

Note : *The event record is 86 cycles in duration and includes user-defined pre-event cycles.*

The record comprises the following information:
- Values sampled from the different signals
- Date
- Characteristics of the recorded channels

The files are recorded in FIFO (First In First Out) type shift storage: the oldest record is erased when a new record is triggered.

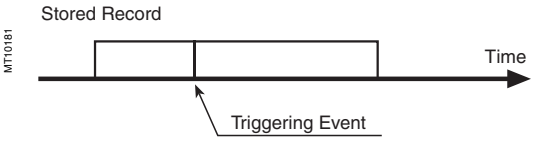
Transfer

Files can be uploaded to a PC locally or remotely:
- Locally
  - By using a PC which is connected to the pocket terminal connector and has the SFT2841 software tool
- Remotely
  - By using a software tool specific to the remote monitoring and control system (e.g., SMS software)

Recovery

The signals are recovered from a record by means of the SFT2826 software tool.

Principle



Characteristics

Record Duration	X Shots before the Triggering Event (1) Total 86 Cycles
Record Content	Set-Up File: Date, Channel Characteristics, Measuring Transformer Ratio Sample File: 12 Values per Event
Analog Signals Recorded (2)	4 Current Channels (Ia, Ib, Ic, Ir) or 4 Voltage Channels (Van, Vbn, Vcn, Vr)
Logical Signals	10 Digital inputs, Outputs O1, Pick-Up
Number of Stored Records	2
File Format	COMTRADE 97

(1) *According to parameter setting with the SFT2841 (default setting 36 shots).*
(2) *According to sensor type and connection.*

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Running Hours Counter/ Operating Time & Thermal Capacity Used

Running Hours Counter/Operating Time

The counter gives the running total of time during which the protected device (motor or transformer) has been operating ($I > 0.1I_B$). The initial counter value may be modified using the SFT2841 software, and is saved every 4 hours.

Readout

The measurements can be accessed via:
- The display of a Sepam™ relay with an advanced user-machine interface (UMI), by pressing the Σ key
- The display of a PC with the SFT2841 software installed
- The communication link

Characteristics

Range	0–65535
Unit	hrs

Thermal Capacity Used

Operation

The thermal capacity used is calculated by the thermal protection algorithm, and is related to the load. This measurement is given as a percentage of the rated thermal capacity.

Saving of Thermal Capacity Used

When the protection unit trips, the current thermal capacity used is increased by 10%(1) and saved. The saved value is reset to zero when the thermal capacity used has decreased sufficiently and the block start time delay is zero. The saved value is used again after a Sepam relay power outage—making it possible to restart, accounting for the temperature buildup that caused the trip.

(1) *The 10% increase is used to take into account the average temperature buildup of motors when starting.*

Readout

The measurements can be accessed via:
- The display of a Sepam relay with an advanced UMI, by pressing the Σ key
- The display of a PC with the SFT2841 software installed
- The communication link
- An analog converter with the MSA141 option

Characteristics

Measurement Range	0–800%
Unit	%
Display Format	3 Significant Digits
Resolution	1%
Refresh Interval	1 s (Typical)

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Operating Time Before Tripping & Delay After Tripping

Remaining Operating Time Before Overload Tripping

Operation

The time is calculated by the thermal protection function, and depends on the thermal capacity used.

Readout

The measurements can be accessed via:

- The display of a Sepam™ relay with an advanced user-machine interface (UMI), by pressing the ⟲ key
- The display of a PC with the SFT2841 software installed
- The communication link

Characteristics

Measurement Range	0–999 min
Unit	min
Display Format	3 Significant Digits
Resolution	1 min
Refresh Interval	1 s (Typical)

Delay After Overload Tripping

Operation

The time is calculated by the thermal protection function, and depends on the thermal capacity used.

Readout

The measurements can be accessed via:

- The display of a Sepam relay with an advanced UMI, by pressing the ⟲ key
- The display of a PC with the SFT2841 software installed
- The communication link

Characteristics

Measurement Range	0–999 min
Unit	min
Display Format	3 Significant Digits
Resolution	1 min
Refresh Period	1 s (Typical)

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Starting/Overload Current & Starting/Overload Time

Operation

The starting/overload time is defined as the time between the moment at which one of the 3 phase currents exceeds 1.2 IB and the moment at which the 3 currents drop back below 1.2 I_B. The maximum phase current obtained during this period is the starting/overload current. The two values are saved in the event of an auxiliary power failure.

Readout

The measurements can be accessed via:

- The display of a Sepam™ relay with an advanced user-machine interface (UMI), by pressing the ⟲ key
- The display of a PC with the SFT2841 software installed
- The communication link

Characteristics

Starting/Overload Time	
Measurement Range	0–300 s
Unit	s or ms
Display Format	3 Significant Digits
Resolution	10 ms or 1 Digit
Refresh Interval	1 s (Typical)
Starting/Overload Current	
Measurement Range	1.2 I_B to 24 I_N (1)
Unit	A or kA
Display Format	3 Significant Digits
Resolution	0.1 A or 1 Digit
Refresh Interval	1 s (Typical)

(1) *Or 65.5 kA.*

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Number of Starts Before Blocking & Block Start Time Delay

Number of Starts Before Blocking

Operation

The number of starts allowed before blocking is calculated by the number of starts protection function, and depends on the thermal state of the motor.

Readout

The measurements can be accessed via:
- The display of a Sepam™ relay with an advanced user-machine interface (UMI), by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link

Resetting to zero

The number of starts counters may be reset to zero as follows, after the entry of a password:
- On the advanced UMI display unit, by pressing the clear key
- On the display of a PC with the SFT2841 software installed

Characteristics

Measurement Range	0–60
Unit	None
Display Format	3 Significant Digits
Resolution	1
Refresh Interval	1 s (Typical)

Block Start Time Delay

Operation

The time delay is calculated by the number of starts protection function. If the number of starts protection function indicates that starting is blocked, the time given represents the waiting time before starting is allowed.

Readout

The number of starts and waiting time can be accessed via:
- The display of a Sepam relay with an advanced UMI, by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link

Characteristics

Measurement Range	0–360 min
Unit	min
Display Format	3 Significant Digits
Resolution	1 min
Refresh Interval	1 s (Typical)

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Cumulative Breaking Current & Number of Operations

Cumulative Breaking Current

Operation

This function indicates the cumulative breaking current in square kiloamperes $(kA)^2$ for five current ranges.

The current ranges (based on the fundamental component) displayed are:
- 0 < I < 2 In
- 2 In < I < 5 In
- 5 In < I < 10 In
- 10 In < I < 40 In
- I > 40 In

The function also provides the total number of operations and the cumulative total of breaking current in $(kA)^2$. Each value is saved in the event of a power failure.

Note : *Refer to switchgear documentation for use of this information.*

Number of Operations

This function counts the number of times the tripping command activates the O1 relay. This value is saved in the event of a power failure.

Readout

The measurements can be accessed via:
- The display of a Sepam™ relay with an advanced user-machine interface (UMI), by pressing the Σ key
- The display of a PC with the SFT2841 software installed
- The communication link

The initial values may be introduced using the SFT2841 software tool to take into account the real state of a used breaking device.

Characteristics

Breaking Current $(kA)^2$	
Range	0–65535 $(kA)^2$
Unit	Primary $(kA)^2$
Accuracy (1)	±10%
Number of Operations	
Range	0–65535

(1) *At In, in reference conditions (IEC 60255-6).*

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Operating Time & Charging Time

Operating Time

Operation

This function gives the opening operating time of a breaking device (1) and the status of the device's open position contact (connected to the I11 input (2)). The function is blocked when the input is set for AC voltage.

Note : *The value is saved in the event of a power failure.*

Readout

The measurement can be accessed via:

- The display of a Sepam™ relay with an advanced user-machine interface (UMI), by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link

(1) *Refer to switchgear documentation for use of this information.*
(2) *Optional MES114, MES114E, or MES114F modules.*

Characteristics

Measurement Range	20–100
Unit	ms
Accuracy	Typically ±1 ms
Display Format	3 Significant Digits

Charging Time

Operation

This function gives the breaking device (1) operating mechanism's charging time (determined by the device closed position status change contact and the end of charging contact connected to the Sepam™ I12 and I24 (2)).

Note : *The value is saved in the event of a power failure.*

Readout

The measurement can be accessed via:

- The display of a Sepam relay with an advanced UMI, by pressing the key
- The display of a PC with the SFT2841 software installed
- The communication link

(1) *Refer to switchgear documentation for use of this information.*
(2) *Optional MES114 or MES114E or MES114F modules.*

Characteristics

Measurement Range	1–20
Unit	s
Accuracy	±0.5 s
Display Format	3 Significant Digits

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Negative Sequence/Current Unbalance **34**
ANSI Code 46

Excessive Starting Time, Locked Rotor **36**
ANSI Code 48/51LR/14

Thermal Overload **37**
ANSI Code 49RMS

Phase Overcurrent **46**
ANSI Code 50/51

Breaker Failure **48**
ANSI Code 50BF

Ground Fault **50**
ANSI Code 50N/51N or 50G/51G

Phase-to-Phase Overvoltage **52**
ANSI Code 59P

Neutral Voltage Displacement **53**
ANSI Code 59N

Starts per Hour **54**
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Recloser **55**
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Overfrequency **57**
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Underfrequency **58**
ANSI Code 81L or 81U

Rate of Change of Frequency **59**
ANSI Code 81R

General **60**
Tripping Curves

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Functions	Settings			Time Delays
ANSI 27P - Phase-to-Phase Undervoltage				
	5–100% of $V_{LL}p$			0.05–300 s
ANSI 27D/47 - Positive Sequence Undervoltage				
	15–60% of $V_{LL}p$			0.05–300 s
ANSI 27R - Remanent Undervoltage				
	5–100% of $V_{LL}p$			0.05–300 s
ANSI 27N - Phase-to-Neutral Undervoltage				
	5–100% of $V_{Ln}p$			0.05–300 s
ANSI 37 - Phase Undercurrent				
	0.15–1 I_B			0.05–300 s
ANSI 38/49T - Temperature Monitoring (8 or 16 RTDs)				
Alarm and Trip Set Points	32 to 356°F (or 0–180°C)			
ANSI 46 - Negative Sequence/Current Unbalance				
Definite Time (DT)	0.1–5 I_B			0.1–300 s
Inverse Definite Minimum Time (IDMT)	0.1–0.5 I_B			0.1–1 s
ANSI 48/51LR/14 - Excessive Starting Time, Locked Rotor				
	0.5–5 I_B	ST Starting Time		0.5–300 s
		LT and LTS Time Delays		0.05–300 s
ANSI 49RMS - Thermal Overload			**Rate 1**	**Rate 2**
Accounting for Negative Sequence Component		0 - 2.25 - 4.5 - 9		
Time Constant	Heating		T1: 1–120 min	T1: 1–120 min
	Cooling		T2: 5–600 min	T2: 5–600 min
Alarm and Tripping Set Points		50–300% of Rated Thermal Capacity		
Cold Curve Modification Factor		0–100%		
Switching of Thermal Settings Conditions		By Logic Input I26 (Transformer)		
		By Is Set Point Adjustable from 0.25 to 8 I_B (Motor)		
Maximum Equipment Temperature		140–392°F (60–200°C)		
ANSI 50/51 - Phase Overcurrent				
	Tripping Time Delay	**Timer Hold**		
Tripping Curve	Definite Time	DT		
	SIT, LTI, VIT, EIT, UIT (1)	DT		
	RI	DT		
	CEI: SIT/A, LTI/B, VIT/B, EIT/C	DT or IDMT		
	IEEE: MI (D), VI (E), EI (F)	DT or IDMT		
	IAC: I, VI, EI	DT or IDMT		
Is Set Point	0.1 to 24 In	DT		Inst; 0.05–300 s
	0.1 to 2.4 In	IDMT		0.1–12.5 s at 10 Is
Timer Hold	Definite Time (DT; Timer Hold)			Inst; 0.05–300 s
	Inverse Definite Minimum Time (IDMT; Reset Time)			0.5–20 s
ANSI 50BF - Breaker Failure				
Presence of Current	0.2–2 In			
Operating Time	0.05–300 s			

(1) *Tripping as of 1.2 Is.*

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Functions	Settings		Time Delays
ANSI 50N/51N or 50G/51G - Ground Fault/Sensitive Ground Fault			
	Tripping Time Delay	**Timer Hold**	
Tripping Curve	Definite Time (DT)	DT	
	SIT, LTI, VIT, EIT, UIT (1)	DT	
	RI	DT	
	CEI: SIT/A,LTI/B, VIT/B, EIT/C	DT or IDMT	
	IEEE: MI (D), VI (E), EI (F)	DT or IDMT	
	IAC: I, VI, EI	DT or IDMT	
Isr Set Point	0.1–15 Inr	DT	Inst; 0.05–300 s
	0.1–1 Inr	IDMT	0.1–12.5 s at 10 Isr
Timer Hold	Definite Time (DT; Timer Hold)		Inst; 0.05–300 s
	Inverse Definite Minimum Time (IDMT; Reset Time)		0.5–20 s
ANSI 59P - Overvoltage Phase-to-Phase			
	50–150% of $V_{LL}p$		0.05–300 s
ANSI 59N - Neutral Voltage Displacement			
	2–80% of $V_{LL}p$		0.05–300 s
ANSI 66 - Starts per Hour			
Starts per Period	1–60	Period	1–6 hrs
Consecutive Starts	1–60	Time Between Starts	0–90 mIn
ANSI 81H or 81O - Overfrequency			
	50–53 Hz or 60–63 Hz		0.1–300 s
ANSI 81L or 81U - Underfrequency			
	45–50 Hz or 55–60 Hz		0.1–300 s
ANSI 81R - Rate of Change of Frequency			
	0.1–10 Hz/s		Inst; 0.15–300 s

(1) *Tripping as of 1.2 Is.*

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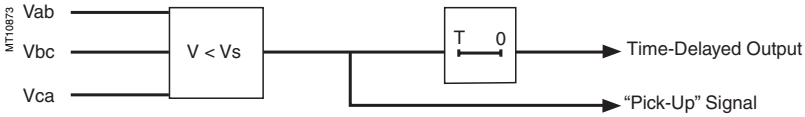
Phase-to-Phase Undervoltage
ANSI Code 27P

Operation

The 3 phase protection function:
- Picks up if one of the 3 phase-to-phase voltages drops below the $V_{LL}s$ set point
- Includes a definite time delay (T)

Block diagram



Characteristics

Vs Set Point	
Setting	5–100% $V_{LL}p$
Accuracy (1)	±2% or 0.005 $V_{LL}p$
Resolution	1%
Drop-Out/Pick-Up Ratio	103% ±2.5%
Time Delay (T)	
Setting	50 ms to 300 s
Accuracy (1)	±2%, or ±25 ms
Resolution	10 ms or 1 Digit
Characteristic Times	
Operation Time	Pick-Up < 35 ms (Typically 25 ms)
Overshoot Time	< 35 ms
Reset Time	< 40 ms

(1) *In reference conditions (IEC 60255-6).*

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Positive Sequence Undervoltage & Phase Rotation Direction Check
ANSI Code 27D/47

Operation

Positive Sequence Undervoltage
The protection picks up when the positive sequence component (V1) of a 3-phase voltage system drops below the Vs1 set point with:

$$V1 = \frac{1}{3}Van + Vbn + x^2 Vcn$$

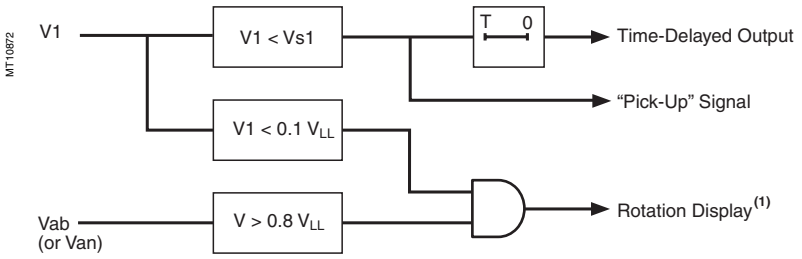
$$V1 = Vab\frac{1}{3} - x^2 Vbc$$

with $V = \frac{V_{LL}}{\sqrt{3}}$ and $x = e^{j\frac{2\pi}{3}}$

- Includes a definite time delay (T)
- Allows drops in motor electrical torque to be detected

Phase Rotation Direction Check
This protection detects the phase rotation direction and accounts for the fact that the phase rotation direction is inverted when the positive sequence voltage is less than 10% of $V_{LL}p$ and the phase-to-phase voltage is greater than 80% of $V_{LL}p$.

Block Diagram



(1) *Displays "rotation" instead of positive sequence voltage measurement.*

Characteristics

Vs1 Set Point	
Setting	15–60% $V_{LL}p$
Accuracy (2)	±2 %
Pick-Up/Drop-Out Ratio	103 % ±2.5 %
Resolution	1 %
Time Delay	
Setting	50 ms to 300 s
Accuracy (2)	±2%, or ±25 ms
Resolution	10 ms or 1 Digit
Characteristics Times	
Operating Time	pick-up < 55 ms
Overshoot Time	< 35 ms
Reset Time	< 35 ms

(2) *In reference conditions (IEC 60255-6).*

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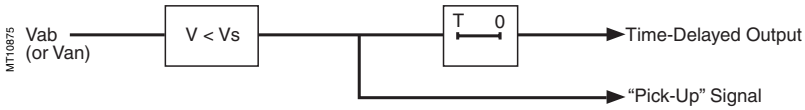
Remanent Undervoltage
ANSI Code 27R

Operation

This single-phase protection:

- Picks up when the Vab phase-to-phase voltage is less than the Vs set point
- Includes a definite time delay

Block Diagram



Characteristics

V_{LL}s Set Point	
Setting	5–100% V_{LL}p
Accuracy (1)	±2% or 0.005 V_{LL}p
Resolution	1%
Drop-Out/Pick-Up Ratio	103 % ±2.5%
Time Delay (T)	
Setting	50 ms to 300 s
Accuracy (1)	±2%, or ±25 ms
Resolution	10 ms or 1 Digit
Characteristic Times	
Operation Time	< 40 ms
Overshoot Time	< 20 ms
Reset Time	< 30 ms

(1) *In reference conditions (IEC 60255-6).*

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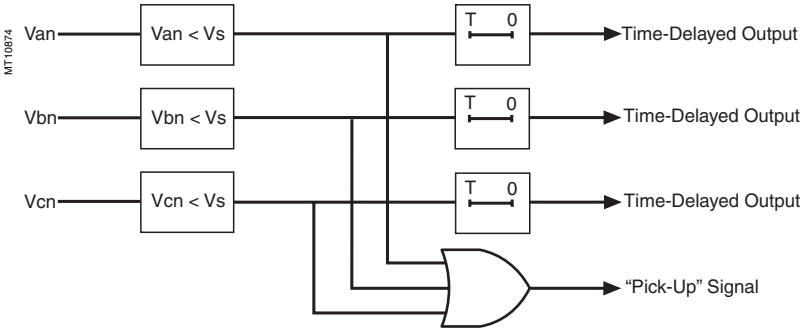
Phase-to-Neutral Undervoltage
ANSI Code 27N

Operation

This 3-phase protection:

- Picks up when one of the 3 phase-to-neutral voltages drops below the Vs set point
- Has 3 independent outputs available for the control matrix
- Is operational if the VTs connected are Van, Vbn, Vcn or Vab, Vbc with a measurement of Vr

Block Diagram



Characteristics

Vs Set Point	
Setting	5–100% $V_{Ln}p$
Accuracy (1)	±2% or 0.005 $V_{Ln}p$
Resolution	1%
Drop-Out/Pick-Up Ratio	103% ±2.5%
Time Delay (T)	
Setting	50 ms to 300 s
Accuracy (1)	±2%, or ±25 ms
Resolution	10 ms or 1 Digit
Characteristic Times	
Operation Time	Pick-Up < 35 ms (Typically 25 ms)
Overshoot Time	< 35 ms
Reset Time	< 40 ms

(1) *In reference conditions (IEC 60255-6).*

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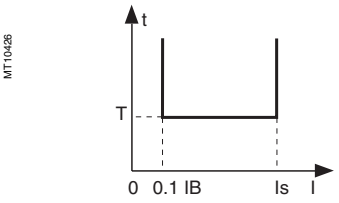
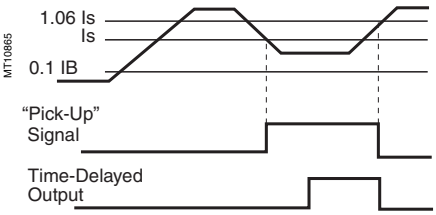
Phase Undercurrent
ANSI Code 37

Operation

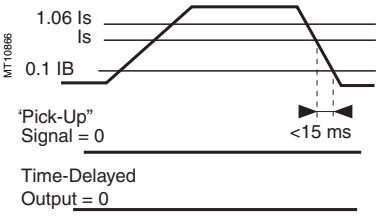
This single-phase protection:
- Picks up when phase 1 current drops below the Is set point
- Is inactive when the current is less than 10% of I_B
- Is insensitive to current drops (breaking) from circuit breaker tripping
- Includes a definite time delay (T)



Operating Principle

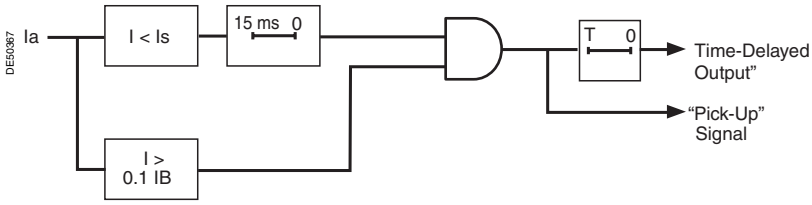


Case of current sag



Case of circuit breaker tripping

Block Diagram



Characteristics

Is Set Point	
Setting	15% $I_B \leqslant Is \leqslant 100\% I_B$ by steps of 1%
Accuracy (1)	±5%
Pick-Up/Drop-Out Ratio	106% ±5% for Is > 0.1 I_N
Time Delay (T)	
Setting	50 ms ⩽ T ⩽ 300 s
Accuracy (1)	±2% or ±25 ms
Resolution	10 ms or 1 Digit
Characteristic Times	
Operating Time	< 50 ms
Overshoot Time	< 35 ms
Reset Time	< 40 ms

(1) *In reference conditions (IEC 60255-6).*

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Temperature Monitoring
ANSI Code 38/49T

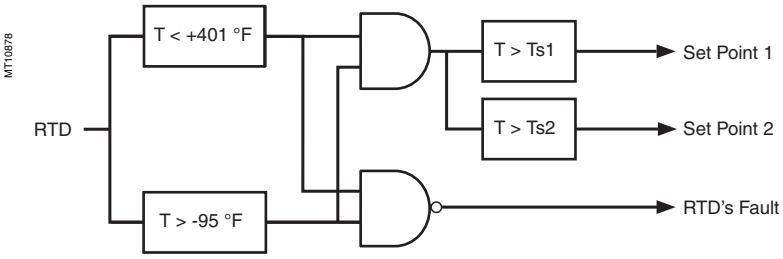
Operation

This protection is associated with a Pt100 platinum (100 Ω at 32°F or 0°C), Ni100, or Ni120 nickel type resistance temperature detector (RTD), in accordance with the IEC 60751 and DIN 43760 standards.

- Picks up when the monitored temperature is greater than the Ts set point
- Has two independent set points:
  - Alarm set point
  - Tripping set point
- When the protection is activated, it detects whether the RTD is shorted or disconnected:
  - RTD shorting is detected if the measured temperature is less than -31°F (-35°C, measurement displayed "*****")
  - RTD disconnection is detected if the measured temperature is greater than +401°F (+205°C, measurement displayed "-****")

Note: *If an RTD fault is detected, the set point output relays are blocked (the protection outputs are set to zero). Also, "RTD fault" is displayed in the control matrix and an alarm message is generated.*

Block Diagram



Characteristics

Ts1 and Ts2 Set Points	°F	°C
Setting	32–356°F	0–180°C
Accuracy (1)	±2.7°F	±1.5°C
Resolution	1°F	1°C
Pick-Up/Drop-Out Difference		3°C ±0.5°
Characteristic Times		
Operation Time		< 5 s

(1) *See* Connection of MET1482 Module *for accuracy derating according to the wiring cross section.*

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Negative Sequence/ Current Unbalance
ANSI Code 46

Operation

The negative sequence/unbalance protection function:
- Picks up if the negative sequence component of phase currents is greater than the operation set point
- Is time-delayed (definite time or inverse definite minimum time — see curve)

The negative sequence current is determined according to the 3 phase currents.

$$\vec{I2} = \frac{1}{3} \times (\vec{Ia} + x^2\vec{Ib} + x\vec{Ic})$$

with $x = e^{j\frac{2\pi}{3}}$

If a Sepam™ relay is connected to 2 phase current sensors only, the negative sequence current is:

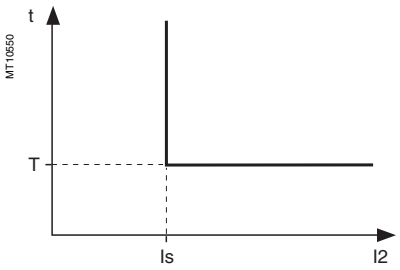
$$\left|\vec{I2}\right| = \frac{1}{\sqrt{3}} \times \left|\vec{Ia} - x^2\vec{Ic}\right|$$

with $x = e^{j\frac{2\pi}{3}}$

Both formulas are equivalent when there is no zero sequence current (ground fault).

Definite Time Protection

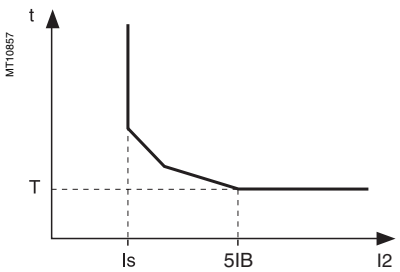
Is is the operation set point expressed in Amps, and T is the protection operation time delay.



Definite Time Protection Principle

Inverse Definite Minimum Time Protection

For I2 > Is, the time delay depends on the value of $I2/I_B$ (I_B: basis current of the protected equipment defined when the general parameters are set). T corresponds to the time delay for $I2/I_B = 5$.



Inverse Definite Minimum Time Protection Principle

The tripping curve is defined according to the following equations:
- for $Is/I_B \leqslant I2/I_B \leqslant 0$

$$t = \frac{3.19}{\left(\frac{I1}{IB}\right)^{1.5}} \times T$$

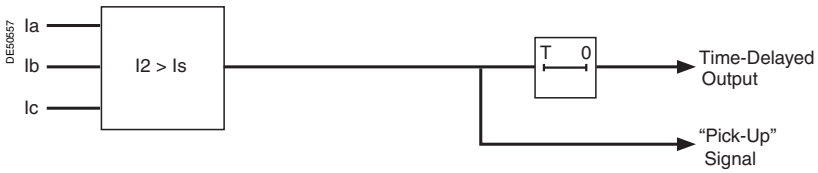
- For $0.5 \leqslant I2/I_B \leqslant 5$

$$t = \frac{4.64}{\left(\frac{I2}{IB}\right)^{0.96}} \times T$$

- For $I2/I_B > 5$

$$t = T$$

Block Diagram



Characteristics

Curve		
Setting	Definite Time (DT), Inverse Definite Minimum Time (IDMT)	
Is Set Point		
Setting	DT	10% $I_B \leqslant Is \leqslant 500\% I_B$
	IDMT	10% $I_B \leqslant Is \leqslant 50\% I_B$
Resolution		1%
Accuracy (1)		±5%
Time Delay (T — Operation Time at 5 I_B)		
Setting	DT	100 ms ⩽ T ⩽ 300 s
	IDMT	100 ms ⩽ T ⩽ 1 s
Resolution		10 ms or 1 Digit
Accuracy (1)	DT	±2% or ±25 ms
	IDMT	±5% or ±35 ms
Pick-Up/Drop-Out Ratio		93.5% ±5%
Characteristic Times		
Operation Time		Pick-Up < 55 ms
Overshoot Time		< 35 ms
Reset Time		< 55 ms

(1) *In reference conditions (IEC 60255-6).*

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Negative Sequence/ Current Unbalance
ANSI Code 46

Determination of tripping time for different negative sequence current values for a given curve

Use the table to find the value of K that corresponds to the required negative sequence current. The tripping time is equal to KT.

Example

given a tripping curve with the setting

$T = 0.5s$

What is the tripping time at 0.6 I_B?

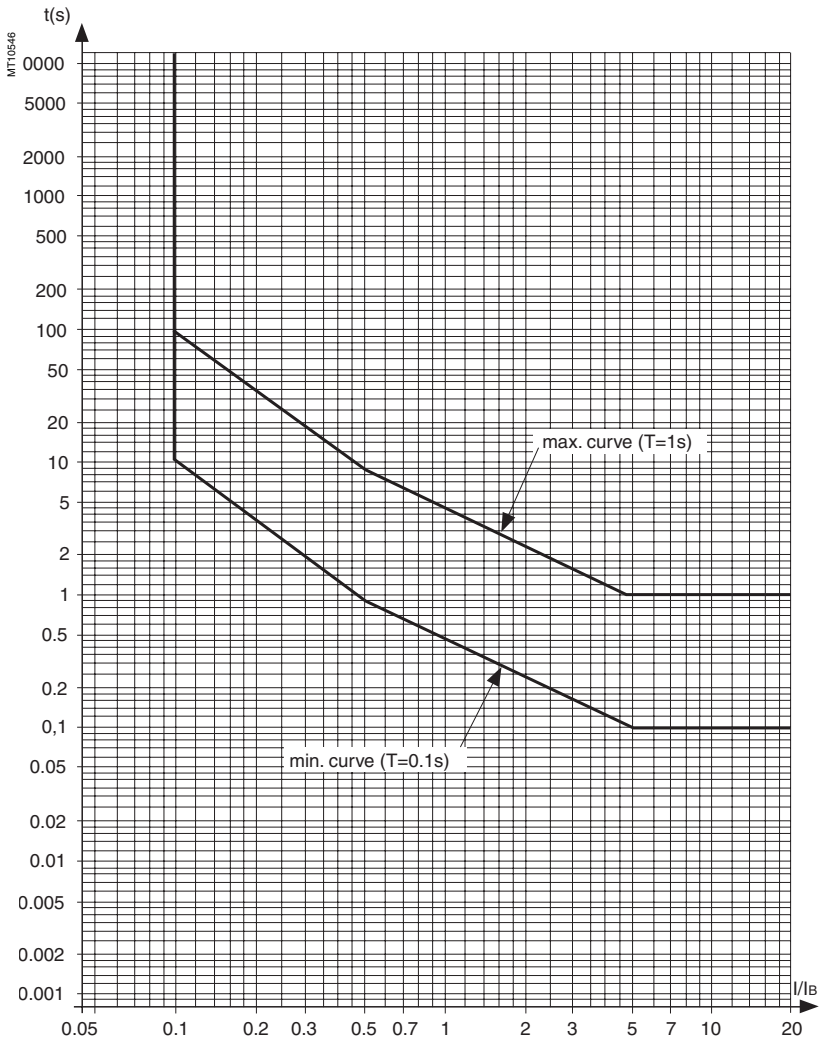
Use the table to find the value of K that corresponds to 60% of I_B. The table reads:

$K = 7.55$

The tripping time is equal to:

$0.5 \times 7.55 = 3.755s$

Inverse Definite Minimum Time (IDMT) Tripping Curve



I2 (% IB)	10	15	20	25	30	33.33	35	40	45	50	55	57.7	60	65	70	75
K	99.95	54.50	35.44	25.38	19.32	16.51	15.34	12.56	10.53	9.00	8.21	7.84	7.55	7.00	6.52	6.11
I2 (% IB) cont'd	80	85	90	95	100	110	120	130	140	150	160	170	180	190	200	210
K cont'd	5.74	5.42	5.13	4.87	4.64	4.24	3.90	3.61	3.37	3.15	2.96	2.80	2.65	2.52	2.40	2.29
I2 (% IB) cont'd	22.	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370
K cont'd	2.14	2.10	2.01	1.94	1.86	1.80	1.74	1.68	1.627	1.577	1.53	1.485	1.444	1.404	1.367	1.332
I2 (% IB) cont'd	380	390	400	410	420	430	440	450	460	470	480	490	⩾ 500			
K cont'd	1.298	1.267	1.236	1.18	1.167	1.154	1.13	1.105	1.082	1.06	1.04	1.02	1			

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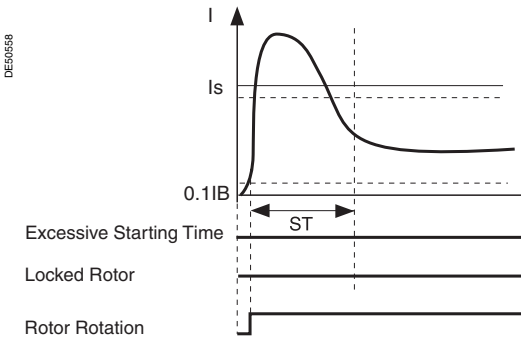
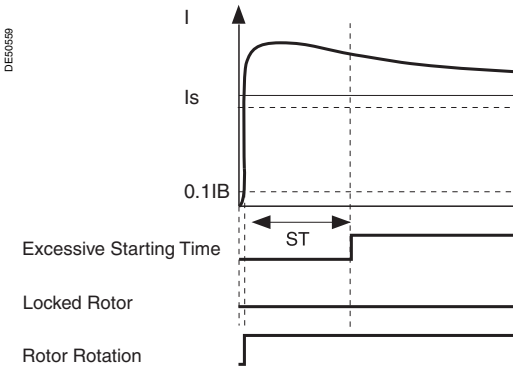
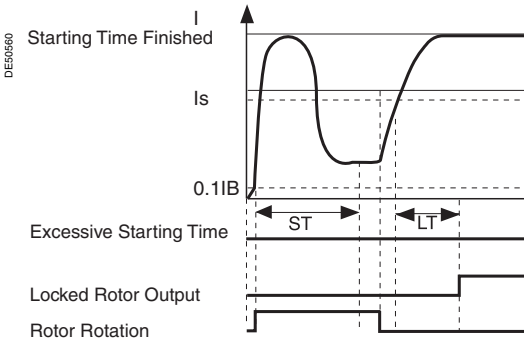
Excessive Starting Time, Locked Rotor
ANSI Code 48/51LR



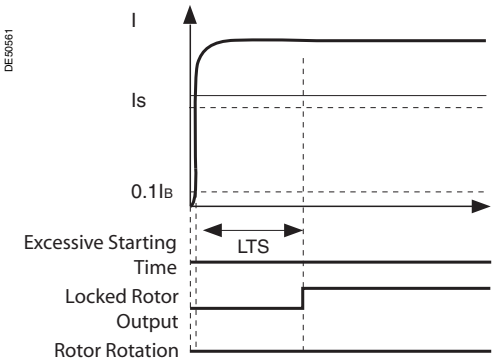
Case of normal starting



Case of excessive starting time



Case of locked rotor output



Tachometer input (I23) required to detect zero speed.
(See "locked rotor on start" description above)

Case of starting locked rotor

Operation

This function is three-phase, and is comprised of two parts:

- Excessive starting time
  - During starting
    - The protection picks up when one of the 3 phase currents is greater than the Is set point for a longer period of time than the ST time delay (normal starting time)
- Locked rotor
  - At the normal operating rate (after starting)
    - The protection picks up when one of the 3 phase currents is greater than the Is set point for a longer period of time than the LT definite time delay, commonly known as "JAM protection"
  - Locked on start
    - Large motors may take a very long time to start (longer than the permissive rotor blocking time), because of their inertia or a reduced voltage supply. To protect such a motor the LTS timer initiates a trip if a start has been detected (I > Is) or if the motor speed is zero. For a normal start, the input I23 (zero-speed-switch) disables this protection.

Motor Re-Acceleration

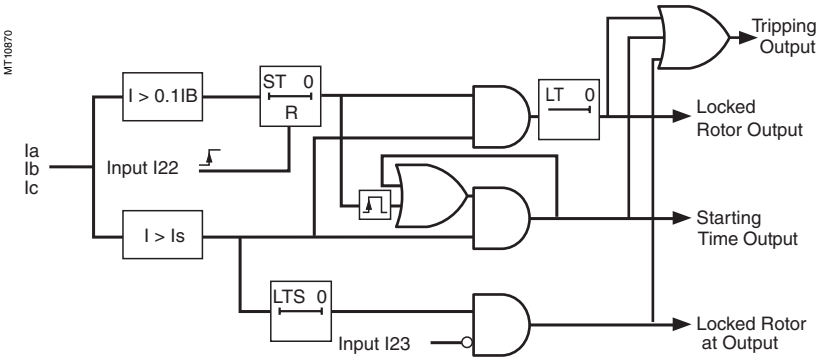
When the motor re-accelerates, it consumes a current in the vicinity of the starting current (> Is) without the current first passing through a value less than 10% of I_B. The ST time delay, which corresponds to the normal starting time, may be reinitialized by a logic data input (input I22). If the application does not have a zero speed switch, motor re-acceleration protection is disabled.

- Reinitialize the **excessive starting time** protection
- Set the **locked rotor** protection LT time delay to a low value

Note: *Starting is detected when the current consumed is 10% greater than the I_B current.*

Note: *Is can be set at the motor current pickup for a mechanically locked rotor (JAM) event.*

Block Diagram



Characteristics

Is Set Point		
Setting		50% $I_B \leqslant Is \leqslant 500\% I_B$
Resolution		1%
Accuracy (1)		±5%
Pick-Up/Drop-Out Ratio		93.5% ±5%
ST, LT, and LTS Time Delays		
Setting	ST	500 ms ⩽ T ⩽ 300 s
	LT	50 ms ⩽ T ⩽ 300 s
	LTS	50 ms ⩽ T ⩽ 300 s
Resolution		10 ms or 1 Digit
Accuracy (1)		±2% or from -25 ms to +40 ms

(1) *In reference conditions (IEC 60255-6).*

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Thermal Overload
ANSI Code 49RMS

Description

This function is used to protect equipment (motors, transformers, generators, lines, and capacitors) against overloads.

Operation Curve

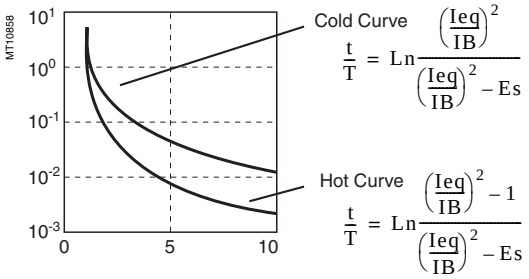
The protection gives a trip command when the heat rise (E), calculated according to the measurement of an equivalent current (Ieq), is greater than the set point (Es). I_B is the base current, typically set to the motor FLA.

The greatest permissible continuous current is:

$$I = IB\sqrt{Es}$$

The protection tripping time is set by the time constant (T).

- The calculated heat rise depends on the current consumed and the previous heat rise state
- The cold curve defines the protection tripping time based on zero heat rise
- The hot curve defines the protection tripping time based on 100 % nominal heat rise



Alarm Set Point, Tripping Set Point

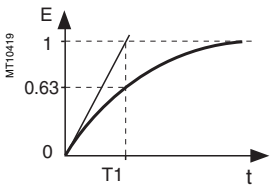
Two set points for heat rise:

- Es1: Alarm
- Es2: Tripping = $(Imax/I_B)^2$
  (if the max operating conditions are unknown use $SF \times FLA$ for Imax)

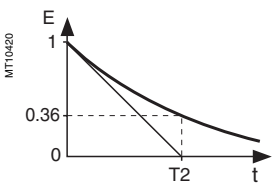
"Hot State" Set Point

When the function is used to protect a motor, this fixed set point is designated for the detection of the hot state used by the number of starts function.

Heat Rise and Cooling Time Constants



Heat Rise Time Constant



Cooling Time Constant

For self-ventilated rotating machines, cooling is more effective when the machine is running than when it is stopped. Determining whether to run or stop the equipment is calculated from the value of the current:

- Running if $I > 0.1\ I_B$
- Stopped if $I < 0.1\ I_B$

Two time constants may be set:

- T1: Heat rise time constant is for running equipment
- T2: Cooling time constant is for stopped equipment

Accounting for Harmonics

The current measured by the thermal protection is an RMS 3-phase current that accounts for up to the 17th harmonic.

Accounting for Ambient Temperature

Most machines are designed to operate at a maximum ambient temperature of 104° F (40° C). The thermal overload function takes into account the ambient temperature (Sepam™ relay equipped with the temperature sensor option (1)) to increase the calculated heat rise value when the temperature measured exceeds 104° F (40° C).

Increase factor: $fa = \frac{Tmax - 104°F}{Tmax - Tambient}$

Tmax is the equipment's maximum temperature (according to insulation class).
Tambient is the measured temperature.

(1) *MET1482 module, has one RTD input (RTD 8) predefined for ambient temperature measurement.*

Adaptation of the Protection to Motor Thermal Withstand

Motor thermal protection is often set based on the hot and cold curves supplied by the machine manufacturer. To fully comply with these curves, additional parameters must be set:

- Initial heat rise, Es0, is used to reduce the cold tripping time.

Modified Cold Curve: $\frac{t}{T} = Ln\frac{\left(\frac{Ieq}{IB}\right)^2 - Es0}{\left(\frac{Ieq}{IB}\right)^2 - Es}$

- A second group of parameters (time constants and set points) accounts for the thermal withstand of locked rotors, when the current is greater than the adjustable set point (Is).

Accounting for Negative Sequence Current

In the case of motors with wound rotors, the presence of a negative sequence component increases heat rise in the motor. The current's negative sequence component is taken into account in the protection by the equation:

$$Ieq = \sqrt{Iph^2 + K \times I2^2}$$

Note: *Iph is the greatest phase current*
I2 is the negative sequence component of the current
K is an adjustable factor, with the following values: 0 - 2.25 - 4.5 - 9

For an induction motor, K is determined as follows:

$$K = 2 \times \frac{Cd}{Cn} \times \frac{1}{g \times \left(\frac{Id}{I_B}\right)^2} - 1$$

Note: *Cn, Cd: rated torque and starting torque*
I_B, Id: basis current and starting current
g: rated slip

Saving of Heat Rise

The current heat rise value is saved in case of auxiliary power outage.

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Block Start
The thermal overload protection can block the closing of the motor's control device until the heat rise drops to allow restarting. This takes into account the heat rise produced by the motor when starting. The blocking function is grouped together with the **starts per hour** protection and the message BlockStart is displayed.

Blocking of the Thermal Overload Protection Function
Tripping of the thermal overload protection function (in the case of a motor) may be locked out, when required by the process, by:
- Logic input (I26)
- Remote control command (TC7) (blocking thermal overload protection)

Remote control command TC13 may be used to enable the operation of the thermal overload protection function.

Taking into Account Two Transformer Operating Rates
Power transformers often have two ventilation operating rates:
- ONAN (Oil Natural, Air Natural)
- ONAF (Oil Natural, Air Forced)

The two groups of thermal overload protection parameters enable both of these operating rates to be taken into account. Switching from one group of thermal settings to the other is controlled by logic input I26. Switching is carried out without any loss of the thermal capacity used value.

Taking into Account Two Motor Operating Rates
Switching from one set of thermal settings to the other is controlled by:
- Logic input I26
- Overrun of a set point by the equivalent current

The two groups of thermal overload protection parameters enable both operating rates to be taken into account. Switching is carried out without any loss of the thermal capacity used value.

User Information
The following information is available:
- Time before restart enabled (in the case of a start blockage)
- Time before tripping (with constant current)
- Heat rise

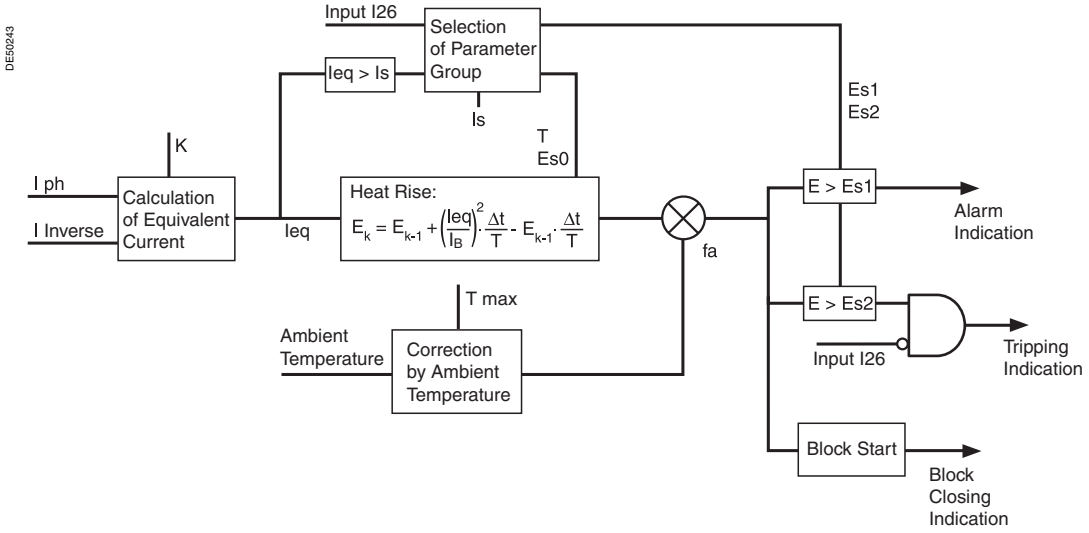
See *Machine Operation Assistance Functions* on page 19.

Characteristics

Set Points		**Group A**	**Group B**
Setting	Es1 Alarm Set Point	50–300%	50–300%
	Es2 Tripping Set Point	50–300%	50–300%
	Es0 Initial Heat Rise	0–100%	0–100%
Resolution		1 %	1 %
Time Constants			
Setting	T1 Running (Heat Rise)	1–120 min	1–120 min
	T2 Stopped (Cooling)	5–600 min	5–600 min
Resolution		1 min	1 min
Accounting for Negative Sequence Component			
Setting	K	0 – 2.25 – 4.5 – 9	
Maximum Equipment Temperature (According to Insulation Class) (2)			
Setting	T max 140°F to 392°F (60°C to 200°C)		
Resolution	1°		
RMS Current Measurement			
Accuracy	5%		
Tripping Time			
Accuracy (1)	2% or 1 s		
Change of Setting Parameters			
By Current Threshold for Motor Is Set Point		0.25–8 I_B	
By Digital Input for Transformer Input		I26	

(1) *In reference conditions (IEC 60255-8).*
(2) *Equipment manufacturer data.*

Block Diagram



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Setting Examples

Example 1

In this example, the following data are available:

- Time constants for on (T1) and off (T2):
  - T1 = 25 min
  - T2 = 70 min
- Maximum curve in steady state: Imax/I_B = 1.05

Setting of Tripping Set Point Es2

Es2 = (Imax/I_B)² = 110%

Note: *If the motor absorbs a current of 1.05 I_B in steady state, the heat rise calculated by the thermal overload protection will reach 110%.*

For unknown operating conditions, assume

$$\text{Imax} = \text{SF} \times \text{FLA}$$

Setting of Alarm Set Point Es1

Es1 = 90% (I/I_B = 0.95)

Knegative: 4.5 (usual value)

The other thermal overload parameters (not accounted for by default) do not need to be set.

Example 2

In this example, the following data are available:

- Motor thermal resistance in the form of hot and cold curves (see the solid line curves, Figure 1)
- Cooling time constant (T2)
- Maximum steady state current (Imax/I_B = 1.05)

Setting of Tripping Set Point Es2

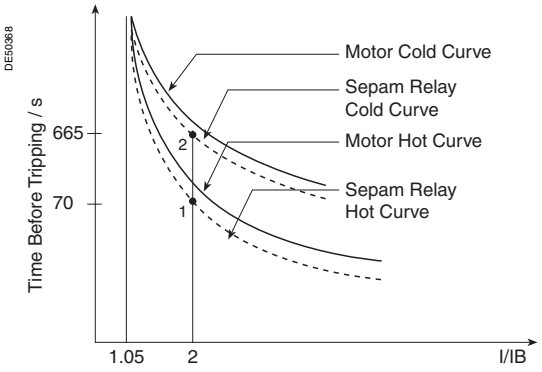
Es2 = (Imax/I_B)² = 110%

Setting of Alarm Set Point Es1:

Es1 = 90% (I/I_B = 0.95)

The manufacturer's hot/cold curves (1) may be used to determine the heating time constant (T1). The approach consists of placing the Sepam™ relay hot/cold curves below the motor curves.

Figure 1: Motor Thermal Resistance and Thermal Overload Tripping Curves



For an overload of 2 I_B, the value t/T1 = 0.0339 (2) is obtained. In order for the Sepam relay to trip at the point 1 (t = 70 s), T1 is equal to 2065 sec ≈ 34 min. With a setting of T1 = 34 min, the tripping time is obtained based on a cold state (point 2). In this case, it is equal to t/T1 = 0.3216 ⇒ t ⇒ 665 sec, i.e. ≈ 11 min, which is compatible with the thermal resistance of the motor when cold.

The negative sequence factor is calculated using the equation defined on page 37.The parameters of the second thermal overload relay do not need to be set (by default, they are not taken into account).

Example 3

In this example, the following data are available:

- Motor thermal resistance in the form of hot and cold curves (see the solid line curves, Figure 1)
- Cooling time constant (T2)
- Maximum steady state current (Imax/I_B = 1.1)

Setting of Tripping Set Point Es2

Es2 = (Imax/I_B)² = 120%

Setting of Alarm Set Point Es1

Es1 = 90% (I/I_B = 0.95)

The time constant (T1) is calculated so that the thermal overload protection trips after 100 s (point 1). With t/T1 = 0.069 (I/I_B = 2 and Es2 = 120%):

$$\Rightarrow T1 = \frac{100\text{s}}{0.069} = 1449\text{s} \cong 24\text{min}$$

The tripping time starting from the cold state is equal to:

$$\frac{t}{T1} = 0.3567 \Rightarrow t = 24\text{min}$$

$$0.3567 = 513\text{s}(\text{point}2')$$

This tripping time (see Figure 2, page 40) is too long since the limit for this overload current is 400 s (point 2).

If T1 is lowered, the thermal overload protection will trip earlier, below point 2. The risk that a hot motor won't start also exists in this case (see Figure 2, in which a lower Sepam relay hot curve would intersect the starting curve with V_{LL} = 0.9 $V_{LL}N$).

The **Es0 parameter** is used to lower the Sepam relay cold curve without moving the hot curve. In this example, the thermal overload protection should trip after 400 s starting from the cold state. The following equation is used to obtain the Es0 value:

$$Es0 = \left[\frac{I_{processed}}{IB}\right] - e^{\frac{t_{necessary}}{T_1}} \times \left[\left[\frac{I_{processed}}{IB}\right]^2 - Es2\right]$$

$t_{necessary}$: Tripping time necessary starting from a cold state
$I_{processed}$: Equipment current

(1) When the machine manufacturer provides both a time constant T1 and the machine hot/cold curves, use the curves is recommended since they are more accurate.
*(2) The charts containing the numerical values of the Sepam **hot curve** may be used, or the equation of the curve which is given on page 37.*

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In numerical values, the following is obtained:

$$Es0 = 4 - e^{\frac{400s}{24 \times 60s}} = 0.3035 \cong 31\%$$

By setting Es0 = 31%, point 2' is moved down to obtain a shorter tripping time, compatible with the motor's thermal resistance when cold (see Figure 3).

Note: *A setting Es0 = 100% therefore means that the hot and cold curves are the same.*

Figure 2: Hot/Cold Curves Not Compatible with the Motor's Thermal Resistance

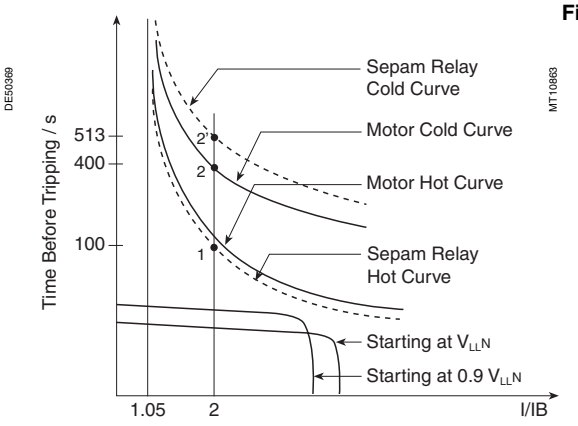
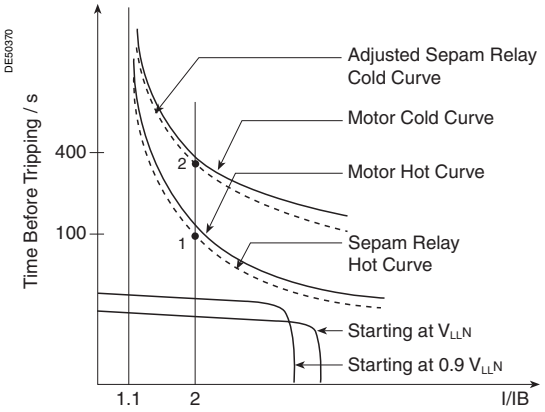


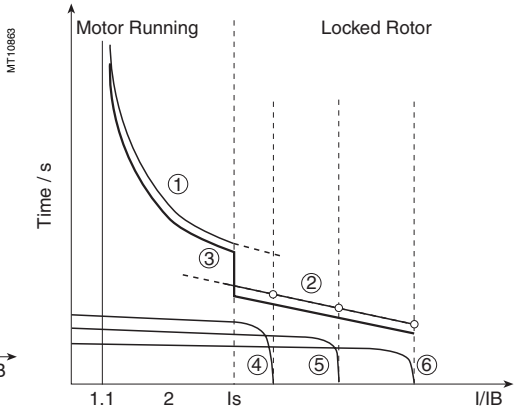
Figure 3: Hot/Cold Curves Compatible with the Motor's Thermal Resistance via the Setting of an Initial Heat Rise Es0



Use of the Additional Setting Group

When a motor rotor is locked or turning very slowly, its thermal behavior is different than one with the rated load. In such conditions, the motor is damaged by overheating of the rotor or stator. For high power motors, rotor overheating is most often a limiting factor. The thermal overload parameters chosen for operation with a low overload are no longer valid. In order to protect the motor in this case, "excessive starting time" protection may be used. Nevertheless, motor manufacturers provide the thermal resistance curves when the rotor is locked, for different voltages at the time of starting.

Figure 4: Locked Rotor Thermal Resistance



①: Thermal Resistance, Motor Running
②: Thermal Resistance, Motor Stopped
③: Sepam™ Relay Tripping Curve
④: Starting at 65% $V_{LL}N$
⑤: Starting at 80% $V_{LL}N$
⑥: Starting at 100% $V_{LL}N$

In order to take these curves into account, the second thermal overload relay may be used. The time constant in this case is, in theory, the shortest one. However, it should not be determined in the same way as that of the first relay.

The thermal overload protection switches between the first and second relay if the equivalent current Ieq exceeds the Is value (set point current).

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Cold Curves for Es0 = 0%

I/I_B Es (%)	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80
50	0.6931	0.6042	0.5331	0.4749	0.4265	0.3857	0.3508	0.3207	0.2945	0.2716	0.2513	0.2333	0.2173	0.2029	0.1900	0.1782	0.1676
55	0.7985	0.6909	0.6061	0.5376	0.4812	0.4339	0.3937	0.3592	0.3294	0.3033	0.2803	0.2600	0.2419	0.2257	0.2111	0.1980	0.1860
60	0.9163	0.7857	0.6849	0.6046	0.5390	0.4845	0.4386	0.3993	0.3655	0.3360	0.3102	0.2873	0.2671	0.2490	0.2327	0.2181	0.2048
65	1.0498	0.8905	0.7704	0.6763	0.6004	0.5379	0.4855	0.4411	0.4029	0.3698	0.3409	0.3155	0.2929	0.2728	0.2548	0.2386	0.2239
70	1.2040	1.0076	0.8640	0.7535	0.6657	0.5942	0.5348	0.4847	0.4418	0.4049	0.3727	0.3444	0.3194	0.2972	0.2774	0.2595	0.2434
75	1.3863	1.1403	0.9671	0.8373	0.7357	0.6539	0.5866	0.5302	0.4823	0.4412	0.4055	0.3742	0.3467	0.3222	0.3005	0.2809	0.2633
80	1.6094	1.2933	1.0822	0.9287	0.8109	0.7174	0.6413	0.5780	0.5245	0.4788	0.4394	0.4049	0.3747	0.3479	0.3241	0.3028	0.2836
85	1.8971	1.4739	1.2123	1.0292	0.8923	0.7853	0.6991	0.6281	0.5686	0.5180	0.4745	0.4366	0.4035	0.3743	0.3483	0.3251	0.3043
90	2.3026	1.6946	1.3618	1.1411	0.9808	0.8580	0.7605	0.6809	0.6147	0.5587	0.5108	0.4694	0.4332	0.4013	0.3731	0.3480	0.3254
95		1.9782	1.5377	1.2670	1.0780	0,9365	0.8258	0.7366	0.6630	0.6012	0.5486	0.5032	0.4638	0.4292	0.3986	0.3714	0.3470
100		2.3755	1.7513	1.4112	1.1856	1.0217	0.8958	0.7956	0.7138	0.6455	0.5878	0.5383	0.4953	0.4578	0.4247	0.3953	0.3691
105		3.0445	2.0232	1.5796	1.3063	1.1147	0.9710	0.8583	0.7673	0.6920	0.6286	0.5746	0.5279	0,4872	0,4515	0,4199	0,3917
110			2.3979	1.7824	1.4435	1.2174	1.0524	0.9252	0.8238	0.7406	0.6712	0.6122	0.5616	0.5176	0.4790	0.4450	0.4148
115			3.0040	2.0369	1.6025	1.3318	1.1409	0,9970	0.8837	0.7918	0.7156	0.6514	0.5964	0.5489	0.5074	0.4708	0.4384
120				2.3792	1.7918	1.4610	1.2381	1.0742	0.9474	0.8457	0.7621	0.6921	0.6325	0.5812	0.5365	0.4973	0.4626
125				2.9037	2.0254	1.6094	1.3457	1.1580	1.0154	0.9027	0.8109	0.7346	0.6700	0.6146	0.5666	0.5245	0.4874
130					2.3308	1.7838	1.4663	1.2493	1.0885	0.9632	0.8622	0.7789	0.7089	0.6491	0.5975	0.5525	0.5129
135					2.7726	1.9951	1.6035	1.3499	1.1672	1.0275	0.9163	0.8253	0.7494	0.6849	0.6295	0.5813	0.5390
140						2.2634	1.7626	1.4618	1.2528	1.0962	0.9734	0.8740	0.7916	0.7220	0.6625	0.6109	0.5658
145						2.6311	1.9518	1.5877	1.3463	1.1701	1.0341	0.9252	0.8356	0.7606	0.6966	0.6414	0.5934
150						3.2189	2.1855	1.7319	1.4495	1.2498	1.0986	0.9791	0.8817	0.8007	0.7320	0.6729	0.6217
155							2.4908	1.9003	1.5645	1.3364	1.1676	1.0361	0.9301	0.8424	0.7686	0.7055	0.6508
160							2.9327	2.1030	1.6946	1.4313	1.2417	1.0965	0.9808	0.8860	0.8066	0.7391	0.6809
165								2.3576	1.8441	1.5361	1.3218	1.1609	1.0343	0.9316	0.8461	0.7739	0.7118
170								2.6999	2.0200	1.6532	1.4088	1.2296	1.0908	0.9793	0.8873	0.8099	0.7438
175								3.2244	2.2336	1.7858	1.5041	1.3035	1.1507	1.0294	0.9302	0.8473	0.7768
180									2.5055	1.9388	1.6094	1.3832	1.2144	1.0822	0.9751	0.8861	0.8109
185									2.8802	2.1195	1.7272	1.4698	1.2825	1.1379	1.0220	0.9265	0.8463
190									3.4864	2.3401	1.8608	1.5647	1.3555	1.1970	1.0713	0.9687	0.8829
195										2.6237	2.0149	1.6695	1.4343	1.2597	1.1231	1.0126	0.9209
200										3.0210	2.1972	1.7866	1.5198	1.3266	1.1778	1.0586	0.9605

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Setting Examples

Cold Curves for Es0 = 0%

I/I_B Es (%)	1.85	1.90	1.95	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60
50	0.1579	0.1491	0.1410	0.1335	0.1090	0.0908	0.0768	0.0659	0.0572	0.0501	0.0442	0.0393	0.0352	0.0317	0.0288	0.0262	0.0239
55	0.1752	0.1653	0.1562	0.1479	0.1206	0.1004	0.0849	0.0727	0.0631	0.0552	0.0487	0.0434	0.0388	0.0350	0.0317	0.0288	0.0263
60	0.1927	0.1818	0.1717	0.1625	0.1324	0.1100	0.0929	0.0796	0.069	0.0604	0.0533	0.0474	0.0424	0.0382	0.0346	0.0315	0.0288
65	0.2106	0.1985	0.1875	0.1773	0.1442	0.1197	0.1011	0.0865	0.075	0.0656	0.0579	0.0515	0.0461	0.0415	0.0375	0.0342	0.0312
70	0.2288	0.2156	0.2035	0.1924	0.1562	0.1296	0.1093	0.0935	0.081	0.0708	0.0625	0.0555	0.0497	0.0447	0.0405	0.0368	0.0336
75	0.2474	0.2329	0.2197	0.2076	0.1684	0.1395	0.1176	0.1006	0.087	0.0761	0.0671	0.0596	0.0533	0.0480	0.0434	0.0395	0.0361
80	0.2662	0.2505	0.2362	0.2231	0.1807	0.1495	0.1260	0.1076	0.0931	0.0813	0.0717	0.0637	0.0570	0.0513	0.0464	0.0422	0.0385
85	0.2855	0.2685	0.2530	0.2389	0.1931	0.1597	0.1344	0.1148	0.0992	0.0867	0.0764	0.0678	0.0607	0.0546	0.0494	0.0449	0.0410
90	0.3051	0.2868	0.2701	0.2549	0.2057	0.1699	0.1429	0.1219	0.1054	0.092	0.0811	0.0720	0.0644	0.0579	0.0524	0.0476	0.0435
95	0.3251	0.3054	0.2875	0.2712	0.2185	0.1802	0.1514	0.1292	0.1116	0.0974	0.0858	0.0761	0.0681	0.0612	0.0554	0.0503	0.0459
100	0.3456	0.3244	0.3051	0.2877	0.2314	0.1907	0.1601	0.1365	0.1178	0.1028	0.0905	0.0803	0.0718	0.0645	0.0584	0.0530	0.0484
105	0.3664	0.3437	0.3231	0.3045	0.2445	0.2012	0.1688	0.1438	0.1241	0.1082	0.0952	0.0845	0.0755	0.0679	0.0614	0.0558	0.0509
110	0.3877	0.3634	0.3415	0.3216	0.2578	0.2119	0.1776	0.1512	0.1304	0.1136	0.1000	0.0887	0.0792	0.0712	0.0644	0.0585	0.0534
115	0.4095	0.3835	0.3602	0.3390	0.2713	0.2227	0.1865	0.1586	0.1367	0.1191	0.1048	0.0929	0.0830	0.0746	0.0674	0.0612	0.0559
120	0.4317	0.4041	0.3792	0.3567	0.2849	0.2336	0.1954	0.1661	0.1431	0.1246	0.1096	0.0972	0.0868	0.0780	0.0705	0.0640	0.0584
125	0.4545	0.4250	0.3986	0.3747	0.2988	0.2446	0.2045	0.1737	0.1495	0.1302	0.1144	0.1014	0.0905	0.0813	0.0735	0.0667	0.0609
130	0.4778	0.4465	0.4184	0.3930	0.3128	0.2558	0.2136	0.1813	0.156	0.1358	0.1193	0.1057	0.0943	0.0847	0.0766	0.0695	0.0634
135	0.5016	0.4683	0.4386	0.4117	0.3270	0.2671	0.2228	0.1890	0.1625	0.1414	0.1242	0.1100	0.0982	0.0881	0.0796	0.0723	0.0659
140	0.5260	0.4907	0.4591	0.4308	0.3414	0.2785	0.2321	0.1967	0.1691	0.147	0.1291	0.1143	0.1020	0.0916	0.0827	0.0751	0.0685
145	0.5511	0.5136	0.4802	0.4502	0.3561	0.2900	0.2414	0.2045	0.1757	0.1527	0.1340	0.1187	0.1058	0.0950	0.0858	0.0778	0.0710
150	0.5767	0.5370	0.5017	0.4700	0.3709	0.3017	0.2509	0.2124	0.1823	0.1584	0.1390	0.1230	0.1097	0.0984	0.0889	0.0806	0.0735
155	0.6031	0.5610	0.5236	0.4902	0.3860	0.3135	0.2604	0.2203	0.189	0.1641	0.1440	0.1274	0.1136	0.1019	0.0920	0.0834	0.0761
160	0.6302	0.5856	0.5461	0.5108	0.4013	0.3254	0.2701	0.2283	0.1957	0.1699	0.1490	0.1318	0.1174	0.1054	0.0951	0.0863	0.0786
165	0.6580	0.6108	0.5690	0.5319	0.4169	0.3375	0.2798	0.2363	0.2025	0.1757	0.1540	0.1362	0.1213	0.1088	0.0982	0.0891	0.0812
170	0.6866	0.6366	0.5925	0.5534	0.4327	0.3498	0.2897	0.2444	0.2094	0.1815	0.1591	0.1406	0.1253	0.1123	0.1013	0.0919	0.0838
175	0.7161	0.6631	0.6166	0.5754	0.4487	0.3621	0.2996	0.2526	0.2162	0.1874	0.1641	0.1451	0.1292	0.1158	0.1045	0.0947	0.0863
180	0.7464	0.6904	0.6413	0.5978	0.4651	0.3747	0.3096	0.2608	0.2231	0.1933	0.1693	0.1495	0.1331	0.1193	0.1076	0.0976	0.0889
185	0.7777	0.7184	0.6665	0.6208	0.4816	0.3874	0.3197	0.2691	0.2301	0.1993	0.1744	0.1540	0.1371	0.1229	0.1108	0.1004	0.0915
190	0.8100	0.7472	0.6925	0.6444	0.4985	0.4003	0.3300	0.2775	0.2371	0.2052	0.1796	0.1585	0.1411	0.1264	0.1140	0.1033	0.0941
195	0.8434	0.7769	0.7191	0.6685	0.5157	0.4133	0.3403	0.2860	0.2442	0.2113	0.1847	0.1631	0.1451	0.1300	0.1171	0.1062	0.0967
200	0.8780	0.8075	0.7465	0.6931	0.5331	0.4265	0.3508	0.2945	0.2513	0.2173	0.1900	0.1676	0.1491	0.1335	0.1203	0.1090	0.0993

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Cold Curves for Es0 = 0%

I/I_B Es (%)	4.80	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	12.50	15.00	17.50	20.00
50	0.0219	0.0202	0.0167	0.0140	0.0119	0.0103	0.0089	0.0078	0.0069	0.0062	0.0056	0.0050	0.0032	0.0022	0.0016	0.0013
55	0.0242	0.0222	0.0183	0.0154	0.0131	0.0113	0.0098	0.0086	0.0076	0.0068	0.0061	0.0055	0.0035	0.0024	0.0018	0.0014
60	0.0264	0.0243	0.0200	0.0168	0.0143	0.0123	0.0107	0.0094	0.0083	0.0074	0.0067	0.0060	0.0038	0.0027	0.0020	0.0015
65	0.0286	0.0263	0.0217	0.0182	0.0155	0.0134	0.0116	0.0102	0.0090	0.0081	0.0072	0.0065	0.0042	0.0029	0.0021	0.0016
70	0.0309	0.0284	0.0234	0.0196	0.0167	0.0144	0.0125	0.0110	0.0097	0.0087	0.0078	0.0070	0.0045	0.0031	0.0023	0.0018
75	0.0331	0.0305	0.0251	0.0211	0.0179	0.0154	0.0134	0.0118	0.0104	0.0093	0.0083	0.0075	0.0048	0.0033	0.0025	0.0019
80	0.0353	0.0325	0.0268	0.0225	0.0191	0.0165	0.0143	0.0126	0.0111	0.0099	0.0089	0.0080	0.0051	0.0036	0.0026	0.0020
85	0.0376	0.0346	0.0285	0.0239	0.0203	0.0175	0.0152	0.0134	0.0118	0.0105	0.0095	0.0085	0.0055	0.0038	0.0028	0.0021
90	0.0398	0.0367	0.0302	0.0253	0.0215	0.0185	0.0161	0.0142	0.0125	0.0112	0.0100	0.0090	0.0058	0.0040	0.0029	0.0023
95	0.0421	0.0387	0.0319	0.0267	0.0227	0.0196	0.0170	0.0150	0.0132	0.0118	0.0106	0.0095	0.0061	0.0042	0.0031	0.0024
100	0.0444	0.0408	0.0336	0.0282	0.0240	0.0206	0.0179	0.0157	0.0139	0.0124	0.0111	0.0101	0.0064	0.0045	0.0033	0.0025
105	0.0466	0.0429	0.0353	0.0296	0.0252	0.0217	0.0188	0.0165	0.0146	0.0130	0.0117	0.0106	0.0067	0.0047	0.0034	0.0026
110	0.0489	0.0450	0.0370	0.0310	0.0264	0.0227	0.0197	0.0173	0.0153	0.0137	0.0123	0.0111	0.0071	0.0049	0.0036	0.0028
115	0.0512	0.0471	0.0388	0.0325	0.0276	0.0237	0.0207	0.0181	0.0160	0.0143	0.0128	0.0116	0.0074	0.0051	0.0038	0.0029
120	0.0535	0.0492	0.0405	0.0339	0.0288	0.0248	0.0216	0.0189	0.0167	0.0149	0.0134	0.0121	0.0077	0.0053	0.0039	0.0030
125	0.0558	0.0513	0.0422	0.0353	0.0300	0.0258	0.0225	0.0197	0.0175	0.0156	0.0139	0.0126	0.0080	0.0056	0.0041	0.0031
130	0.0581	0.0534	0.0439	0.0368	0.0313	0.0269	0.0234	0.0205	0.0182	0.0162	0.0145	0.0131	0.0084	0.0058	0.0043	0.0033
135	0.0604	0.0555	0.0457	0.0382	0.0325	0.0279	0.0243	0.0213	0.0189	0.0168	0.0151	0.0136	0.0087	0.0060	0.0044	0.0034
140	0.0627	0.0576	0.0474	0.0397	0.0337	0.0290	0.0252	0.0221	0.0196	0.0174	0.0156	0.0141	0.0090	0.0062	0.0046	0.0035
145	0.0650	0.0598	0.0491	0.0411	0.0349	0.0300	0.0261	0.0229	0.0203	0.0181	0.0162	0.0146	0.0093	0.0065	0.0047	0.0036
150	0.0673	0.0619	0.0509	0.0426	0.0361	0.0311	0.0270	0.0237	0.0210	0.0187	0.0168	0.0151	0.0096	0.0067	0.0049	0.0038
155	0.0696	0.0640	0.0526	0.0440	0.0374	0.0321	0.0279	0.0245	0.0217	0.0193	0.0173	0.0156	0.0100	0.0069	0.0051	0.0039
160	0.0720	0.0661	0.0543	0.0455	0.0386	0.0332	0.0289	0.0253	0.0224	0.0200	0.0179	0.0161	0.0103	0.0071	0.0052	0.0040
165	0.0743	0.0683	0.0561	0.0469	0.0398	0.0343	0.0298	0.0261	0.0231	0.0206	0.0185	0.0166	0.0106	0.0074	0.0054	0.0041
170	0.0766	0.0704	0.0578	0.0484	0.0411	0.0353	0.0307	0.0269	0.0238	0.0212	0.0190	0.0171	0.0109	0.0076	0.0056	0.0043
175	0.0790	0.0726	0.0596	0.0498	0.0423	0.0364	0.0316	0.0277	0.0245	0.0218	0.0196	0.0177	0.0113	0.0078	0.0057	0.0044
180	0.0813	0.0747	0.0613	0.0513	0.0435	0.0374	0.0325	0.0285	0.0252	0.0225	0.0201	0.0182	0.0116	0.0080	0.0059	0.0045
185	0.0837	0.0769	0.0631	0.0528	0.0448	0.0385	0.0334	0.0293	0.0259	0.0231	0.0207	0.0187	0.0119	0.0083	0.0061	0.0046
190	0.0861	0.0790	0.0649	0.0542	0.0460	0.0395	0.0344	0.0301	0.0266	0.0237	0.0213	0.0192	0.0122	0.0085	0.0062	0.0048
195	0.0884	0.0812	0.0666	0.0557	0.0473	0.0406	0.0353	0.0309	0.0274	0.0244	0.0218	0.0197	0.0126	0.0087	0.0064	0.0049
200	0.0908	0.0834	0.0684	0.0572	0.0485	0.0417	0.0362	0.0317	0.0281	0.0250	0.0224	0.0202	0.0129	0.0089	0.0066	0.0050

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Thermal Overload
ANSI Code 49RMS
Setting Examples

Hot Curves

I/I_B Es (%)	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80
105		0.6690	0.2719	0.1685	0.1206	0.0931	0.0752	0.0627	0.0535	0.0464	0.0408	0.0363	0.0326	0.0295	0.0268	0.0245	0.0226
110		3.7136	0.6466	0.3712	0.2578	0.1957	0.1566	0.1296	0.1100	0.0951	0.0834	0.0740	0.0662	0.0598	0.0544	0.0497	0.0457
115			1.2528	0.6257	0.4169	0.3102	0.2451	0.2013	0.1699	0.1462	0.1278	0.1131	0.1011	0.0911	0.0827	0.0755	0.0693
120			3.0445	0.9680	0.6061	0.4394	0.3423	0.2786	0.2336	0.2002	0.1744	0.1539	0.1372	0.1234	0.1118	0.1020	0.0935
125				1.4925	0.8398	0.5878	0.4499	0.3623	0.3017	0.2572	0.2231	0.1963	0.1747	0.1568	0.1419	0.1292	0.1183
130				2.6626	1.1451	0.7621	0.5705	0.4537	0.3747	0.3176	0.2744	0.2407	0.2136	0.1914	0.1728	0.1572	0.1438
135					1.5870	0.9734	0.7077	0.5543	0.4535	0.3819	0.3285	0.2871	0.2541	0.2271	0.2048	0.1860	0.1699
140					2.3979	1.2417	0.8668	0.6662	0.5390	0.4507	0.3857	0.3358	0.2963	0.2643	0.2378	0.2156	0.1967
145						1.6094	1.0561	0.7921	0.6325	0.5245	0.4463	0.3869	0.3403	0.3028	0.2719	0.2461	0.2243
150						2.1972	1.2897	0.9362	0.7357	0.6042	0.5108	0.4408	0.3864	0.3429	0.3073	0.2776	0.2526
155						3.8067	1.5950	1.1047	0.8508	0.6909	0.5798	0.4978	0.4347	0.3846	0.3439	0.3102	0.2817
160							2.0369	1.3074	0.9808	0.7857	0.6539	0.5583	0.4855	0.4282	0.3819	0.3438	0.3118
165							2.8478	1.5620	1.1304	0.8905	0.7340	0.6226	0.5390	0.4738	0.4215	0.3786	0.3427
170								1.9042	1.3063	1.0076	0.8210	0.6914	0.5955	0.5215	0.4626	0.4146	0.3747
175								2.4288	1.5198	1.1403	0.9163	0.7652	0.6554	0.5717	0.5055	0.4520	0.4077
180								3.5988	1.7918	1.2933	1.0217	0.8449	0.7191	0.6244	0.5504	0.4908	0.4418
185									2.1665	1.4739	1.1394	0.9316	0.7872	0.6802	0.5974	0.5312	0.4772
190									2.7726	1.6946	1.2730	1.0264	0.8602	0.7392	0.6466	0.5733	0.5138
195									4.5643	1.9782	1.4271	1.1312	0.9390	0.8019	0.6985	0.6173	0.5518
200										2.3755	1.6094	1.2483	1.0245	0.8688	0.7531	0.6633	0.5914

I/I_B Es (%)	1.85	1.90	1.95	2.00	2.20	2.40	2.60	2.80	3.00	3,20	3,40	3.60	3.80	4.00	4.20	4.40	4.60
105	0.0209	0.0193	0.0180	0.0168	0.0131	0.0106	0.0087	0.0073	0.0063	0.0054	0.0047	0.0042	0.0037	0.0033	0.0030	0.0027	0.0025
110	0.0422	0.0391	0.0363	0.0339	0.0264	0.0212	0.0175	0.0147	0.0126	0.0109	0.0095	0.0084	0.0075	0.0067	0.0060	0.0055	0.0050
115	0.0639	0.0592	0.0550	0.0513	0.0398	0.0320	0.0264	0.0222	0.0189	0.0164	0.0143	0.0126	0.0112	0.0101	0.0091	0.0082	0.0075
120	0.0862	0.0797	0.0740	0.0690	0.0535	0.0429	0.0353	0.0297	0.0253	0.0219	0.0191	0.0169	0.0150	0.0134	0.0121	0.0110	0.0100
125	0.1089	0.1007	0.0934	0.0870	0.0673	0.0540	0.0444	0.0372	0.0317	0.0274	0.0240	0.0211	0.0188	0.0168	0.0151	0.0137	0.0125
130	0.1322	0.1221	0.1132	0.1054	0.0813	0.0651	0.0535	0.0449	0.0382	0.0330	0.0288	0.0254	0.0226	0.0202	0.0182	0.0165	0.0150
135	0.1560	0.1440	0.1334	0.1241	0.0956	0.0764	0.0627	0.0525	0.0447	0.0386	0.0337	0.0297	0.0264	0.0236	0.0213	0.0192	0.0175
140	0.1805	0.1664	0.1540	0.1431	0.1100	0.0878	0.0720	0.0603	0.0513	0.0443	0.0386	0.0340	0.0302	0.0270	0.0243	0.0220	0.0200
145	0.2055	0.1892	0.1750	0.1625	0.1246	0.0993	0.0813	0.0681	0.0579	0.0499	0.0435	0.0384	0.0341	0.0305	0.0274	0.0248	0.0226
150	0.2312	0.2127	0.1965	0.1823	0.1395	0.1110	0.0908	0.0759	0.0645	0.0556	0.0485	0.0427	0.0379	0.0339	0.0305	0.0276	0.0251
155	0.2575	0.2366	0.2185	0.2025	0.1546	0.1228	0.1004	0.0838	0.0712	0.0614	0.0535	0.0471	0.0418	0.0374	0.0336	0.0304	0.0277
160	0.2846	0.2612	0.2409	0.2231	0.1699	0.1347	0.1100	0.0918	0.0780	0.0671	0.0585	0.0515	0.0457	0.0408	0.0367	0.0332	0.0302
165	0.3124	0.2864	0.2639	0.2442	0.1855	0.1468	0.1197	0.0999	0.0847	0.0729	0.0635	0.0559	0.0496	0.0443	0.0398	0.0360	0.0328
170	0.3410	0.3122	0.2874	0.2657	0.2012	0.1591	0.1296	0.1080	0.0916	0.0788	0.0686	0.0603	0.0535	0.0478	0.0430	0.0389	0.0353
175	0.3705	0.3388	0.3115	0.2877	0.2173	0.1715	0.1395	0.1161	0.0984	0.0847	0.0737	0.0648	0.0574	0.0513	0.0461	0.0417	0.0379
180	0.4008	0.3660	0.3361	0.3102	0.2336	0.1840	0.1495	0.1244	0.1054	0.0906	0.0788	0.0692	0.0614	0.0548	0.0493	0.0446	0.0405
185	0.4321	0.3940	0.3614	0.3331	0.2502	0.1967	0.1597	0.1327	0.1123	0.0965	0.0839	0.0737	0.0653	0.0583	0.0524	0.0474	0.0431
190	0.4644	0.4229	0.3873	0.3567	0.2671	0.2096	0.1699	0.1411	0.1193	0.1025	0.0891	0.0782	0.0693	0.0619	0.0556	0.0503	0.0457
195	0.4978	0.4525	0.4140	0.3808	0.2842	0.2226	0.1802	0.1495	0.1264	0.1085	0.0943	0.0828	0.0733	0.0654	0.0588	0.0531	0.0483
200	0.5324	0.4831	0.4413	0.4055	0.3017	0.2358	0.1907	0.1581	0.1335	0.1145	0.0995	0.0873	0.0773	0.0690	0.0620	0.0560	0.0509

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Thermal Overload
ANSI Code 49RMS
Setting Examples

Hot Curves

I/I_B Es (%)	4.80	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	12.50	15.00	17.50	20.00
105	0.0023	0.0021	0.0017	0.0014	0.0012	0.0010	0.0009	0.0008	0.0007	0.0006	0.0006	0.0005	0.0003	0.0002	0.0002	0.0001
110	0.0045	0.0042	0.0034	0.0029	0.0024	0.0021	0.0018	0.0016	0.0014	0.0013	0.0011	0.0010	0.0006	0.0004	0.0003	0.0003
115	0.0068	0.0063	0.0051	0.0043	0.0036	0.0031	0.0027	0.0024	0.0021	0.0019	0.0017	0.0015	0.0010	0.0007	0.0005	0.0004
120	0.0091	0.0084	0.0069	0.0057	0.0049	0.0042	0.0036	0.0032	0.0028	0.0025	0.0022	0.0020	0.0013	0.0009	0.0007	0.0005
125	0.0114	0.0105	0.0086	0.0072	0.0061	0.0052	0.0045	0.0040	0.0035	0.0031	0.0028	0.0025	0.0016	0.0011	0.0008	0.0006
130	0.0137	0.0126	0.0103	0.0086	0.0073	0.0063	0.0054	0.0048	0.0042	0.0038	0.0034	0.0030	0.0019	0.0013	0.0010	0.0008
135	0.0160	0.0147	0.0120	0.0101	0.0085	0.0073	0.0064	0.0056	0.0049	0.0044	0.0039	0.0035	0.0023	0.0016	0.0011	0.0009
140	0.0183	0.0168	0.0138	0.0115	0.0097	0.0084	0.0073	0.0064	0.0056	0.0050	0.0045	0.0040	0.0026	0.0018	0.0013	0.0010
145	0.0206	0.0189	0.0155	0.0129	0.0110	0.0094	0.0082	0.0072	0.0063	0.0056	0.0051	0.0046	0.0029	0.0020	0.0015	0.0011
150	0.0229	0.0211	0.0172	0.0144	0.0122	0.0105	0.0091	0.0080	0.0070	0.0063	0.0056	0.0051	0.0032	0.0022	0.0016	0.0013
155	0.0253	0.0232	0.0190	0.0158	0.0134	0.0115	0.0100	0.0088	0.0077	0.0069	0.0062	0.0056	0.0035	0.0025	0.0018	0.0014
160	0.0276	0.0253	0.0207	0.0173	0.0147	0.0126	0.0109	0.0096	0.0085	0.0075	0.0067	0.0061	0.0039	0.0027	0.0020	0.0015
165	0.0299	0.0275	0.0225	0.0187	0.0159	0.0136	0.0118	0.0104	0.0092	0.0082	0.0073	0.0066	0.0042	0.0029	0.0021	0.0016
170	0.0323	0.0296	0.0242	0.0202	0.0171	0.0147	0.0128	0.0112	0.0099	0.0088	0.0079	0.0071	0.0045	0.0031	0.0023	0.0018
175	0.0346	0.0317	0.0260	0.0217	0.0183	0.0157	0.0137	0.0120	0.0106	0.0094	0.0084	0.0076	0.0048	0.0034	0.0025	0.0019
180	0.0370	0.0339	0.0277	0.0231	0.0196	0.0168	0.0146	0.0128	0.0113	0.0101	0.0090	0.0081	0.0052	0.0036	0.0026	0.0020
185	0.0393	0.0361	0.0295	0.0246	0.0208	0.0179	0.0155	0.0136	0.0120	0.0107	0.0096	0.0086	0.0055	0.0038	0.0028	0.0021
190	0.0417	0.0382	0.0313	0.0261	0.0221	0.0189	0.0164	0.0144	0.0127	0.0113	0.0101	0.0091	0.0058	0.0040	0.0030	0.0023
195	0.0441	0.0404	0.0330	0.0275	0.0233	0.0200	0.0173	0.0152	0.0134	0.0119	0.0107	0.0096	0.0061	0.0043	0.0031	0.0024
200	0.0464	0.0426	0.0348	0.0290	0.0245	0.0211	0.0183	0.0160	0.0141	0.0126	0.0113	0.0102	0.0065	0.0045	0.0033	0.0025

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Phase Overcurrent
ANSI Code 50/51

Description

The phase overcurrent function comprises four independant elements divided into two groups of two items called Group A and Group B, respectively. The use of the two groups may be chosen by parameter settings:

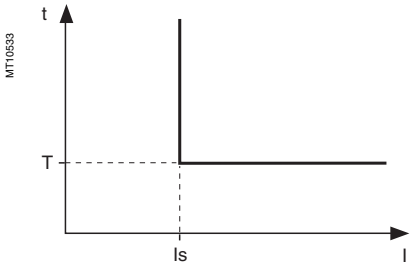
- Operation with Group A or Group B exclusively, with switching from one group to the other dependent on the state of logic input I13 exclusively, or by remote control (TC3, TC4)
  I13 = 0 group A
  I13 = 1 group B
- Operation with Group A and Group B active for 4-set point operation
- Enabling/disabling of each group of 2 elements (A, B)

Operation

The phase overcurrent protection function is three-pole, and picks up if one, two, or three of the phase currents reach the operation set point. Also, it is time-delayed, and it may have a definite time (DT) or an inverse definite minimum time (IDMT) time delay, according to their curves.

Definite Time Protection

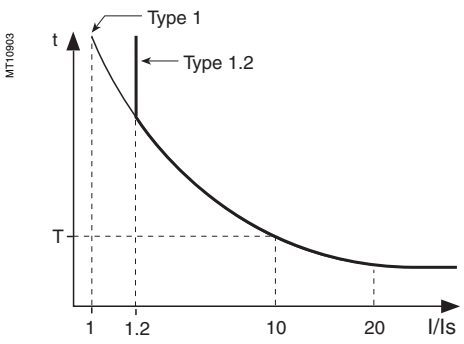
Is is the operation set point expressed in Amps, and T is the protection operation time delay.



Definite Time Protection Principle

Inverse Definite Minimum Time Protection

Inverse definite minimum time protection operates in accordance with the IEC (60255-3), BS 142 and IEEE (C-37112) standards.



Inverse Definite Minimum Time Protection Principle

The Is setting is the vertical asymptote of the curve, and T is the operation time delay for 10 Is.

The tripping time for I/Is values of less than 1.2 depends on the type of curve chosen.

Name of Curve	Type
Standard Inverse Time (SIT)	1.2
Very Inverse Time (VIT or LTI)	1.2
Extremely Inverse Time (EIT)	1.2
Ultra Inverse Time (UIT)	1.2
RI Curve	1
IEC Standard Inverse Time SIT/A	1
IEC Very Inverse Time VIT or LTI/B	1
IEC Extremely Inverse Time EIT / C	1
IEEE Moderately Inverse (IEC / D)	1
IEEE Very Inverse (IEC / E)	1
IEEE Extremely Inverse (IEC / F)	1
IAC Inverse	1
IAC Very Inverse	1
IAC Extremely Inverse	1

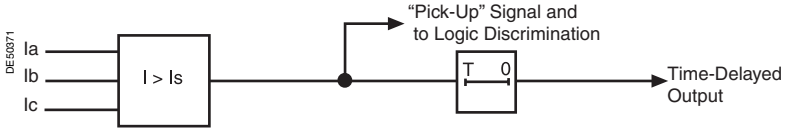
Note: *The curve equations are given in* IDMT protection functions, page 61.

The function takes into account current variations during the time delay interval. For currents with a very large amplitude, the protection function has a definite time characteristic:

- If I > 20 Is, tripping time is the time that corresponds to 20 Is
- If I > 40 In, tripping time is the time that corresponds to 40 In

Note: *In current transformer rated current is defined when the general settings are made.*

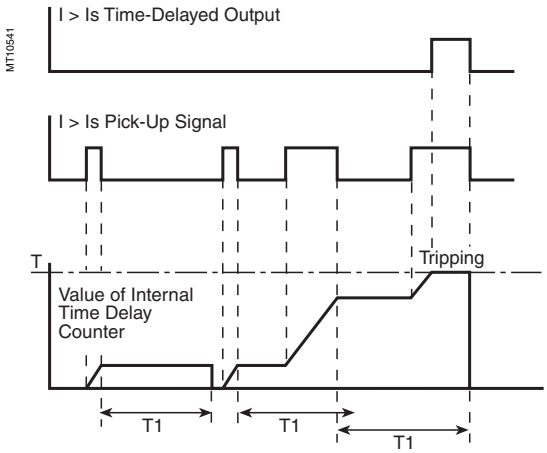
Block Diagram



Timer Hold Delay

The function includes an adjustable timer hold delay (T1):

- Definite time (timer hold) for all the tripping curves



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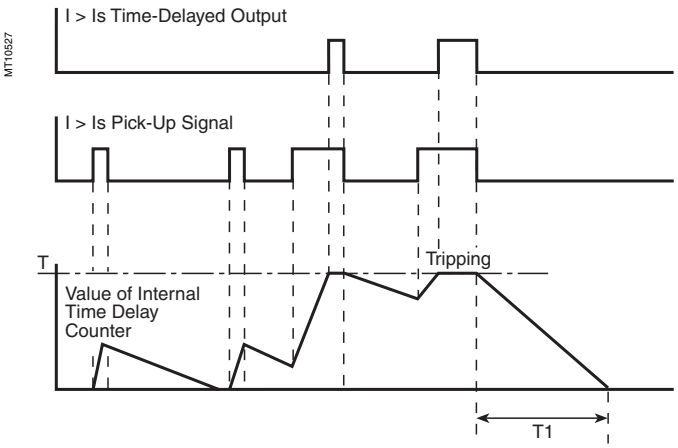
Phase Overcurrent
ANSI Code 50/51

■ Inverse Definite Minimum Time (IDMT) for IEC, IEEE, and IAC curves



Characteristics

Tripping Curve		
Setting		Definite Time (DT), IDMT: Chosen According to List on Previous Page
Is Set Point		
Setting	DT	0.1 I_N ⩽ Is ⩽ 24 I_N, Expressed in Amps
	IDMT	0.1 I_N ⩽ Is ⩽ 2.4 I_N, Expressed in Amps
Resolution		1 A or 1 Digit
Accuracy (1)		±5% or ±0.01 I_N
Drop Out/Pick-Up Ratio		93.5% ±5% or > (1 - 0.02 In/Is) x 100%
Time Delay (T—Operation Time at 10 Is)		
Setting	DT	inst. 50 ms ⩽ T ⩽ 300 s
	IDMT	100 ms ⩽ T ⩽ 12.5 s or TMS (2)
Resolution		10 ms or 1 Digit
Accuracy (1)	DT	±2% or from -10 ms to +25 ms
	IDMT	Class 5 or from -10 ms to +25 ms
Timer Hold Delay (T1)		
Definite Time (Timer Hold)		0; 0.05–300 s
Inverse Definite Minimum Time (Reset Time) (3)		0.5–20 s
Characteristic Times		
Operation Time		Pick-Up < 35 ms at 2 Is (typically 25 ms)
		Confirmed Instantaneous: ■ Inst. < 50 ms at 2 Is for Is ⩾ 0.3 I_N (Typically 35 ms) ■ Inst. < 70 ms at 2 Is for Is < 0.3 I_N (Typically 50 ms)
Overshoot Time		< 35 ms
Reset Time		< 50 ms (for T1 = 0)

(1) *In reference conditions (IEC 60255-6).*

(2) *Setting Ranges in TMS (Time Multiplier Setting) Mode*

Inverse (SIT) and IEC SIT/A:	*0.04–4.20*
Very Inverse (VIT) and IEC VIT/B:	*0.07–8.33*
Very Inverse (LTI) and IEC LTI/B:	*0.01–0.93*
Ext Inverse (EIT) and IEC EIT/C:	*0.13–15.47*
IEEE Moderately Inverse:	*0.42–51.86*
IEEE Very Inverse:	*0.73–90.57*
IEEE Extremely Inverse:	*1.24–154.32*
IAC Inverse:	*0.34 –42.08*
IAC Very Inverse:	*0.61–75.75*
IAC Extremely Inverse:	*1.08–134.4*

(3) *Only for Standardized Tripping Curves of the IEC, IEEE, and IAC types.*

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Breaker Failure
ANSI Code 50BF

Operation

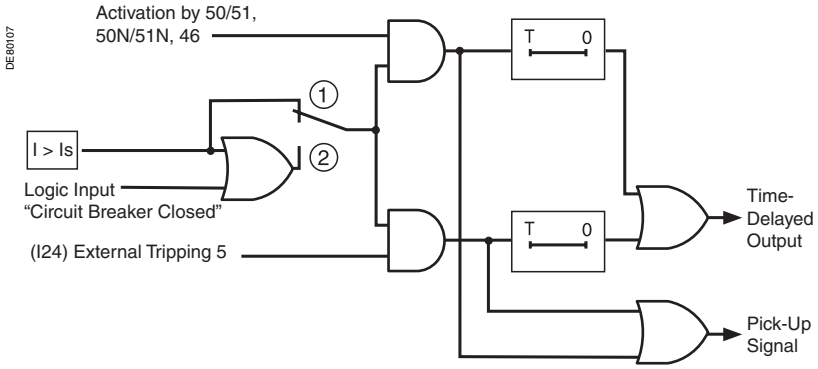
This function is designed to detect when a breaker fails, i.e. it fails to open when a trip command is sent. The "breaker failure" function is activated:

- By a trip command issued by the overcurrent protection functions (50/51, 50N/51N, 46)
- By an external trip command sent by logic input I24 (I24 should be assigned to external trip function 5)

It checks that the current has disappeared within the time interval specified by the time delay (T). It can also take into account the position of the breaker read on the logic inputs to determine effective breaker opening. When the circuit breaker control function is used, the breaker failure function is activated automatically by protection units 50/51, 50N/51N and 46, which trip the breaker. However, the user may set the protective functions that activate the breaker failure function. When the circuit breaker control function is not used, the user has the choice of overcurrent protection functions to associate with the breaker failure protection function. The protection delayed output should be assigned to a logic output using the control matrix.

Launching and stopping the time delay counter T both depend on the presence of a current above the set point (I > Is) or, according to the parameter setting, on the absence of breaker opening.

Block Diagram



Setting: (1) Without Taking into Account Circuit Breaker Position
(2) With Taking into Account Circuit Breaker Position

Note: *When an external trip command is issued on input I24 of an MES114 module configured for AC operation, the 50BF operating characteristics are not guaranteed.*

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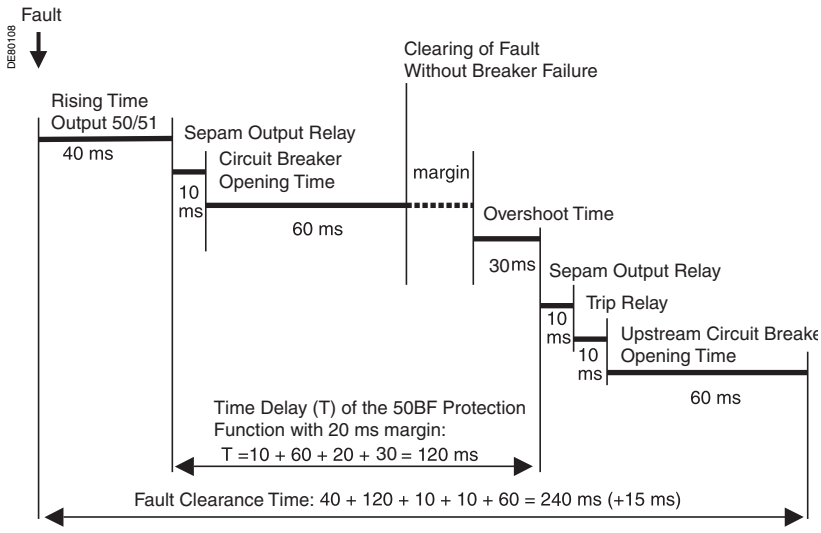
Breaker Failure
ANSI Code 50BF

Setting Example

The example below shows how to determine the time delay setting for the breaker failure function:

- Overcurrent protection setting (T = inst.)
- Circuit breaker operating time (60 ms)
- Auxiliary relay operating time to open upstream circuit breakers (10 ms)



The time delay for the breaker failure function is the sum of the following times:

- Rise time for the Sepam™ O1 output relay (10 ms)
- Circuit breaker opening time (60 ms)
- Overshoot time for the breaker failure function (30 ms)
- To avoid nuisance tripping by the upstream breakers, select a margin of approximately 20 ms

This gives a time delay of T = 120 ms.

Characteristics

Is Set Point	
Setting	0.2–2 In
Accuracy (1)	±5%
Resolution	0.1 A
Drop-Out/Pick-Up Ratio	(87.5 ±10)%
Time Delay (T)	
Setting	0.05 to 300 s
Accuracy (1)	±2%, or 0 ms to +15 ms
Resolution	10 ms or 1 Digit
Characteristic Times	
Overshoot Time	< 30 ms
Taking into Account the Circuit Breaker Position	
Setting	With/Without
Choice of Protection Functions that Activate the 50BF Protection in the Absence of Circuit Breaker Control	
50/51-1A, 50/51-1B, 50/51-2A, 50/51-2B, 50N/51N-1A, 50N/51N-1B, 50N/51N-2A 50N/51N-2B, 46	

(1) *Under reference conditions (IEC 60255-6).*

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Ground Fault
ANSI Code 50N/51N or 50G/51G

Description

The ground fault function comprises four independant elements divided into two groups of two settings called Group A and Group B respectively.

May be chosen by parameter setting:
- Operation with Group A or Group B exclusively, with switching from one group to the other dependent on the state of logic input I13 exclusively, or by remote control (TC3, TC4), I13 = 0 group A, I13 = 1 group B
- Operation with Group A and Group B active for four-set point operation
- Enabling/disabling of each group of 2 elements (A, B)

Operation

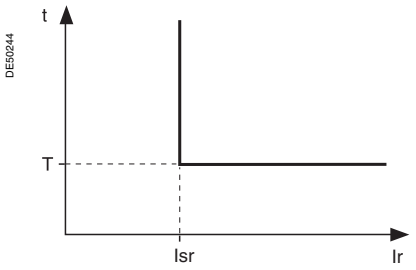
The ground fault protection function is single-pole, and activates if the ground fault current reaches the triggering set point. Also, its time-delay may be a definite time (DT), or an inverse definite minimum time (IDMT) delay, according to the tripping curves.

The protection function includes second harmonic restraint which provides greater stability when transformers are energized (measurement of residual current by the sum of the 3 phase CTs).

Note: *The restraint function disables tripping, regardless of the fundamental current and can be selected by the parameter settings. Also, the protection function can be blocked by input I23 for the S23 application only.*

Definite Time Protection

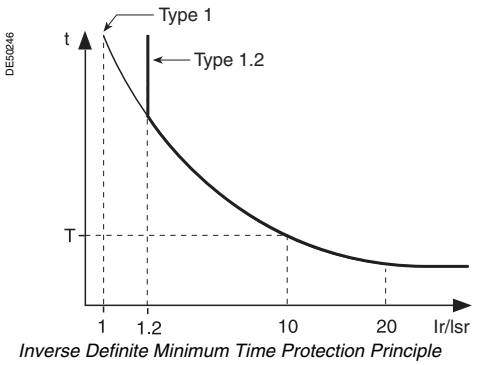
Is0 is the operation set point expressed in Amps, and T is the protection operation time delay.



Definite Tme Protection Principle

Inverse Definite Minimum Time Protection

Inverse definite minimum time protection operates in accordance with the IEC (60255-3), BS 142 and IEEE (C-37112) standards.



Inverse Definite Minimum Time Protection Principle

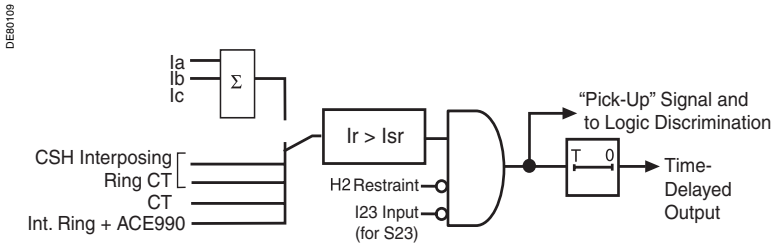
The Isr setting is the vertical asymptote of the curve, and T is the operation time delay for 10 Isr. The tripping time for Ir/Isr values of less than 1.2 depends on the type of curve chosen.

Name of Curve	Type
Standard inverse time (SIT)	1.2
Very inverse time (VIT or LTI)	1.2
Extremely inverse time (EIT)	1.2
Ultra inverse time (UIT)	1.2
RI curve	1
IEC standard inverse time SIT / A	1
IEC very inverse time VIT or LTI / B	1
IEC extremely inverse time EIT / C	1
IEEE moderately inverse (IEC / D)	1
IEEE very inverse (IEC / E)	1
IEEE extremely inverse (IEC / F)	1
IAC inverse	1
IAC very inverse	1
IAC extremely inverse	1

Note: *The curve equations are given in* IDMT Protection Functions, *page 61.*

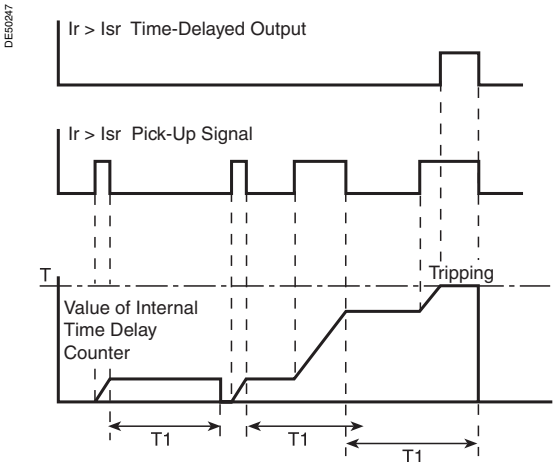
The function takes into account current variations during the time delay interval. For currents with a very large amplitude, the protection function has a definite time characteristic:
- If Ir > 20 Isr, then tripping time is the time that corresponds to 20 Isr
- If Ir > 15 Inr (1), then tripping time is the time that corresponds to 15 Inr

Block Diagram



Timer Hold Delay

The function includes an adjustable timer hold delay (T1):
- Definite time (timer hold) for all the tripping curves



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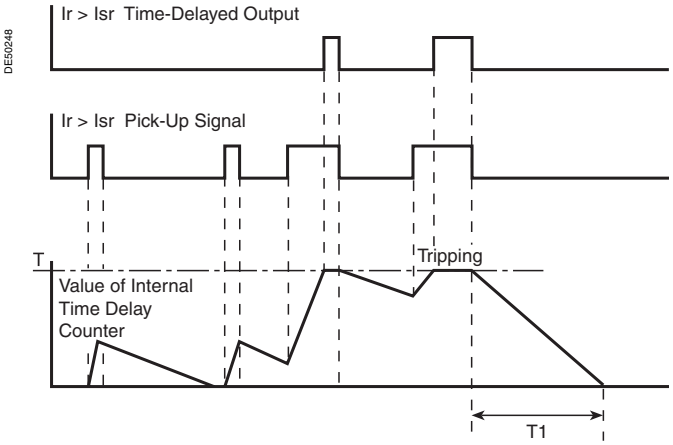
Ground Fault
ANSI Code 50N/51N or 50G/51G

■ Inverse Definite Minimum Time (IDMT) for IEC, IEEE and IAC curves



Characteristics

Tripping Curve		
Setting		Definite Time (DT), Inverse Definite Minimum Time (IDMT): Chosen according to the list on the previous page
Is0 Set Point		
Definite Time Setting		0.1 Inr ⩽ Isr ⩽ 15 Inr Expressed in Amps
	Sum of CTs (1) (5)	0.1 Inr ⩽ Isr ⩽ 15 Inr
	With CSH Sensor	
	2 A Rating	0.2–30 A
	20 A Rating	2–300 A
	CT	0.1 Inr ⩽ Isr ⩽ 15 Inr (min. 0.1 A)
	Zero Sequence CT	
	With ACE990	0.1 Inr < Isr < 15 Inr
Inverse Definite Minimum Time Time Setting		0.1 Inr ⩽ Isr ⩽ Inr (1) Expressed in Amps
	Sum of CTs (1) (5)	0.1 Inr ⩽ Isr ⩽ Inr
	With CSH Sensor	
	2 A Rating	0.2–2 A
	20 A Rating	2–20 A
	CT	0.1 Inr ⩽ Isr ⩽ Inr (min. 0.1 A)
	Zero Sequence CT	
	With ACE990	0.1 Inr ⩽ Isr ⩽ Inr
Resolution		0.1 A or 1 digit
Accuracy (2)		±5% or ±0.01 Inr
Drop Out/Pick-Up Ratio		93.5% ±5% (With CSH Sensor, CT or Zero Sequence CT + ACE990)
		93.5% ±5% or > (1 - 0.015 In0/Is0) x 100% (sum of CTs)
Harmonic 2 Restraint		
Fixed threshold		17% ±5%
Time Delay (T—Operation Time at 10 Is0)		
Setting	DT	inst. 50 ms ⩽ T ⩽ 300 s
	IDMT (3)	100 ms ⩽ T ⩽ 12.5 s or TMS (3)
Resolution		10 ms or 1 Digit
Accuracy (2)	DT	±2 % or from -10 ms to +25 ms
	IDMT	Class 5 or from -10 ms to +25 ms
Timer Hold Delay (T1)		
Definite Time (Timer Hold)		0; 0.05–300 s
Inverse Definite Minimum Time (4)		0.5–300 s
Characteristic Times		
Operation Time		Pick-Up < 35 ms at 2 Isr (typically 25 ms)
		Confirmed Instantaneous: ■ Inst. < 50 ms at 2 Isr for Isr ⩾ 0.3 Inr (typically 35 ms) ■ Inst. < 70 ms at 2 Isr for Isr < 0.3 Inr (typically 50 ms)
Overshoot Time		< 35 ms
Reset Time		< 40 ms (for T1 = 0)

(1) Inr = In if the sum of the three phase currents is used for the measurement.
Inr = sensor rating if the measurement is taken by a CSH zero sequence CT.
Inr = In of the CT if the measurement is taken by a 1 A or 5 A current transformer.
(2) In reference conditions (IEC 60255-6).
(3) Setting ranges in TMS (Time Multiplier Setting) mode
Inverse (SIT) and IECIEC SIT/A: 0.04–4.20
Very Inverse (VIT) and IEC VIT/B: 0.07–8.33
Very Inverse (LTI) and IEC LTI/B:0.01–0.93
Ext Inverse (EIT) and IEC EIT/C: 0.13–15.47
IEEE Moderately Inverse: 0.42–51.86
IEEE Very Inverse: 0.73–90.57
IEEE Extremely Inverse: 1.24–154.32
IAC Inverse: 0.34–42.08
IAC Very Inverse: 0.61–75.75
IAC Extremely Inverse:1.08–134.4
(4) Only for standardized tripping curves of the IEC, IEEE and IAC types.
(5) For Isr < 0.4 Inr, the minimum time delay is 300 ms. If a shorter time delay is needed, use the CT + CSH30 or CT + CCA634 combination.

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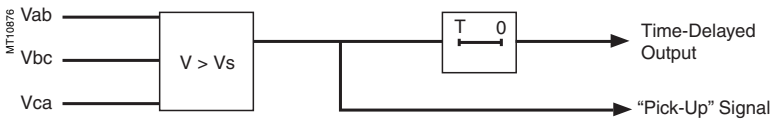
Phase-to-Phase Overvoltage
ANSI Code 59P

Operation

This protection is three-phase:

- It picks up when one of the phase-to-phase voltages concerned is greater than the Vs set point
- The protection includes a definite time delay

Block Diagram



Characteristics

V_{LL}s Set Point	
Setting	50–150% V_{LL}p (2)
Accuracy (1)	±2% or 0.005 V_{LL}p
Resolution	1%
Drop-Out/Pick-Up Ratio	97% ±1%
Time Delay (T)	
Setting	50 ms to 300 s
Accuracy (1)	±2%, or ±25 ms
Resolution	10 ms or 1 Digit
Characteristic Times	
Operation Time	Pick-Up < 35 ms (Typically 25 ms)
Overshoot Time	< 35 ms
Reset Time	< 40 ms

(1) *In reference conditions (IEC 60255-6).*
(2) *135% V_{LL}p with TP 230 V / $\sqrt{3}$.*

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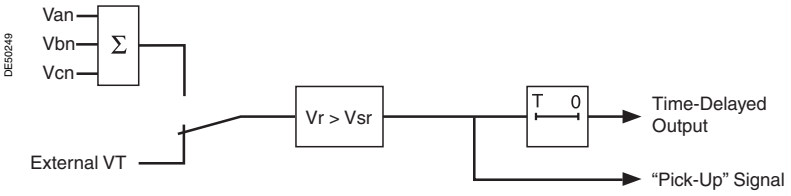
Neutral Voltage Displacement
ANSI Code 59N

Operation

The protection function picks up if the residual voltage Vr is above a Vsr set point, with $\vec{V}r = \vec{V}an + \vec{V}bn + \vec{V}cn$

- It includes a definite time delay (T)
- The residual voltage is either calculated from the 3 phase voltages or measured by an external VT

Block Diagram



Characteristics

Vs0 Set Point	
Setting	2–80% $V_{LL}p$ if V_{Nsr} (2) = sum of 3Vs 2–80% $V_{LL}p$ if V_{Nsr} (2) = $V_{LL}s/\sqrt{3}$ 5–80% $V_{LL}p$ if V_{Nsr} (2) = $V_{LL}s/3$
Accuracy (1)	±2% or ±0.005 $V_{LL}p$
Resolution	1%
Drop-Out/Pick-Up Ratio	97 % ±1%
Time Delay (T)	
Setting	50 ms to 300 s
Accuracy (1)	±2%, or ±25 ms
Resolution	10 ms or 1 Digit
Characteristic Times	
Operation Time	Pick-Up < 55 ms
Overshoot Time	< 35 ms
Reset Time	< 55 ms

(1) *In reference conditions (IEC 60255-6).*

(2) *V_{Nsr} is one of the general settings.*

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Starts per Hour
ANSI Code 66

Operation

The 3-phase function picks up when the number of starts reaches the following limits:
- Maximum number of starts allowed per period (P) of time (Nt)
- Maximum allowed number of consecutive hot starts (Nh)
- Maximum allowed number of consecutive cold starts (Nc)

The function indicates:
- The number of starts (dependent on the motor's thermal state) still allowed before the maximum, if the protection has not activated
- Waiting time before a start is allowed, if the protection has activated

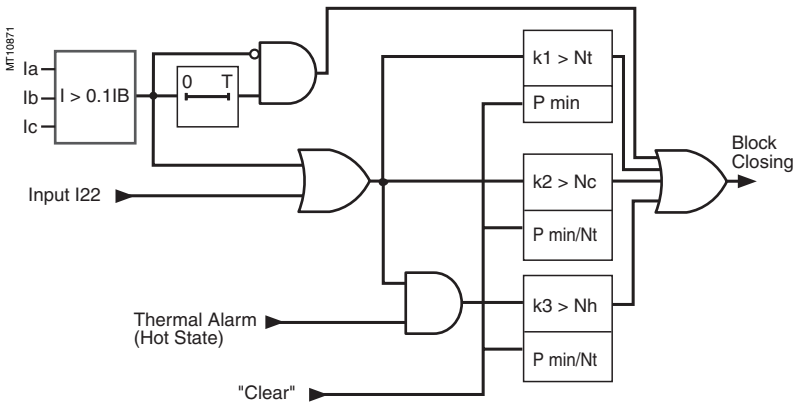
Note: *Starting is detected when the current consumed becomes greater than 10% of the I_B current.*

User Information

The following information is available
(see *Machine Operation Assistance Functions* on page 19 for more information):
- The waiting time before a start is allowed
- The number of starts still allowed

The number of consecutive starts is the number starts counted during the last P/Nt minutes, with Nt being the number of starts allowed per period. The motor hot state corresponds to the exceeded fixed set point (50% heat rise) of the thermal overload function. When the motor re-accelerates, it undergoes a stress similar to that of starting without the current first passing through a value less than 10% of I_B, in which case the number of starts is not incremented. It is possible, however, to increment the number of starts when re-acceleration occurs by logic data input (input I22).

Block Diagram



Characteristics

Period of Time (P)	
Setting	1–6 hrs
Resolution	1
Nt Total Number of Starts	
Setting	1–60
Resolution	1
Nh and Nc Number of Consecutive Starts	
Setting (1)	1 to Nt
Resolution	1
Time Delay (T) Between Starts	
Setting	0 min ⩽ T ⩽ 90 min
Resolution	1 min or 1 Digit

(1) *With Nc ⩽ Nh.*

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Recloser
ANSI Code 79

Operation

Initialization of the Recloser

The recloser is ready to operate if all of the following conditions are met:
- "CB control" function is activated and the recloser is in service
- Circuit breaker is closed
- Block time delay is not running
- None of the recloser blocking conditions is true (see below)

Recloser Shots

- Case of a cleared fault:
  - Following a reclosing operation, if the fault does not appear after the memory time delay has run out, the recloser reinitializes and a message is displayed (see example 1, page 56)
- Case of a fault that is not cleared:
  - Following instantaneous or time-delayed tripping by the protection unit, activation of the isolation time delay associated with the first active shot

At the end of the time delay, a closing command activates the memory time delay. If the protection unit detects the fault before the end of the time delay, a tripping command activates the following reclosing shot:
- After all the active shots have been run, if the fault still persists, a final trip command is given, a message is displayed and closing is locked out until acknowledged, according to the parameter setting of the protection function
- Closing on a fault
  - If the circuit breaker closes on a fault, or if the fault appears before the end of the lockout time delay, the recloser is blocked

Block Recloser Conditions

The recloser is blocked in the following conditions:
- Voluntary open or close command
- Recloser put out of service
- Receipt of a lockout command on the lockout logic input I26
- Appearance of a switchgear-related fault, such as trip circuit fault, or control fault
- Opening of the circuit breaker by external tripping via inputs I21, I22 or I23

Characteristics

Reclosing Shots			**Setting**
Number of Shots			1–4
Activation of Shot 1 (1)		Overcurrent 1	Inst./Delayed/Inactive
		Overcurrent 2	
		Ground Fault 1	
		Ground Fault 2	
Activation of Shots 2, 3 and 4 (1)		Overcurrent 1	Inst./Delayed/Inactive
		Overcurrent 2	
		Ground Fault 1	
		Ground Fault 2	
Time Delays			
Memory Time Delay			0.05–300 s
Isolation Time Delay	Shot 1		0.05–300 s
	Shot 2		
	Shot 3		
	Shot 4		
Lockout Time Delay			0.05–300 s
Accuracy	±2% or 25 ms		
Resolution	10 ms or 1 Digit		

(1) *If a protection function that is inactive in relation to the recloser leads to circuit breaker opening, the recloser is blocked.*

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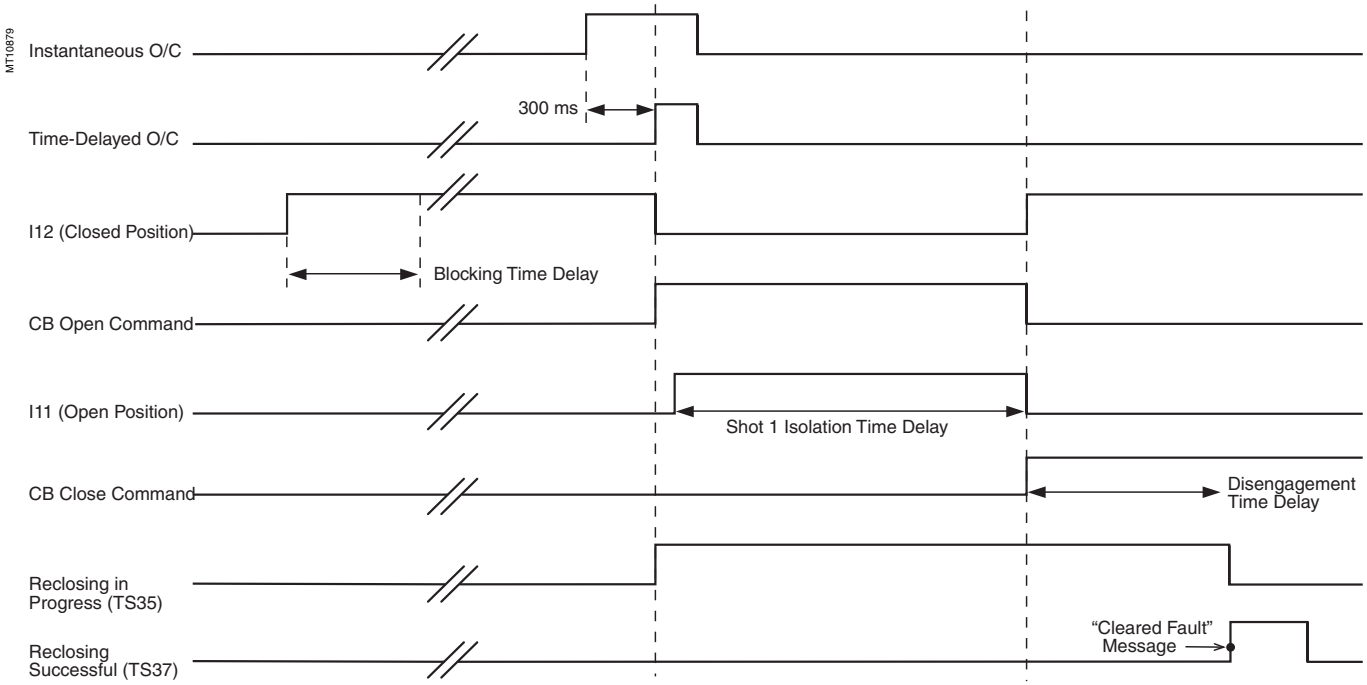
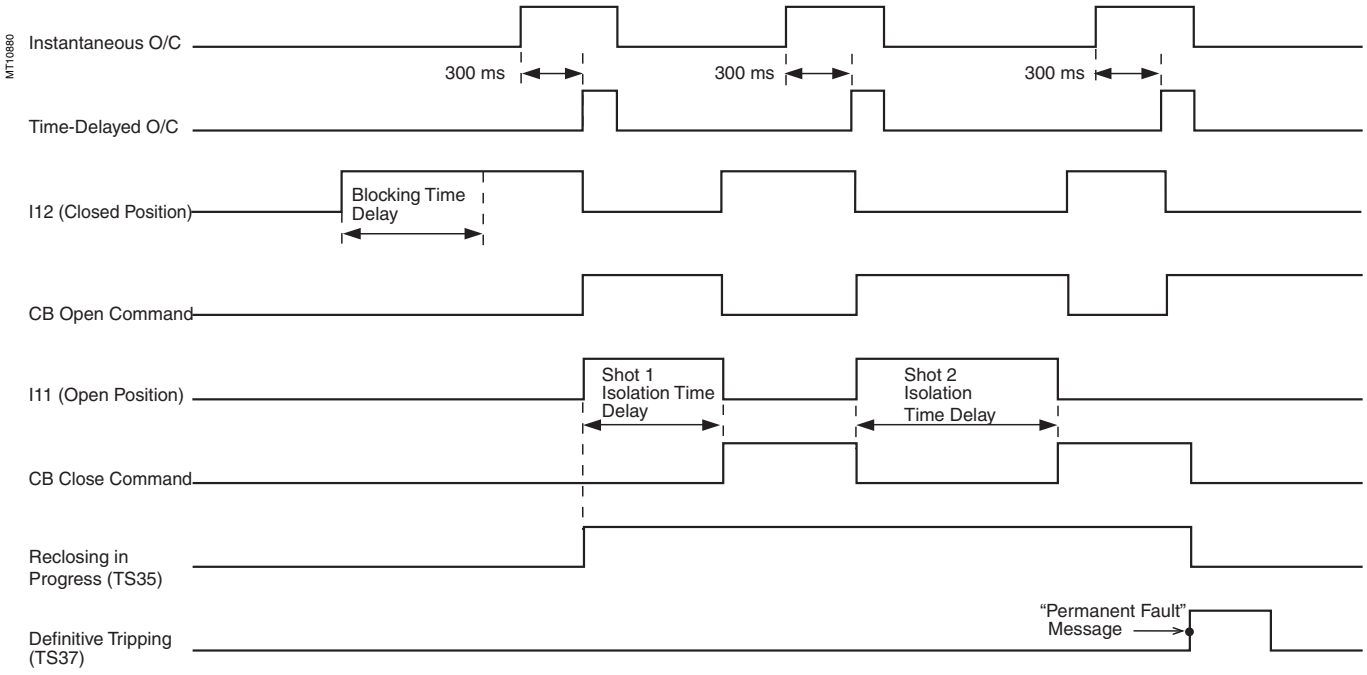
Example 1: Case of successful reclosing after the first shot, activation with 300 ms time-delayed O/C protection



Example 2: Case of definitive tripping after two shots activated by 300 ms time-delayed O/C protection



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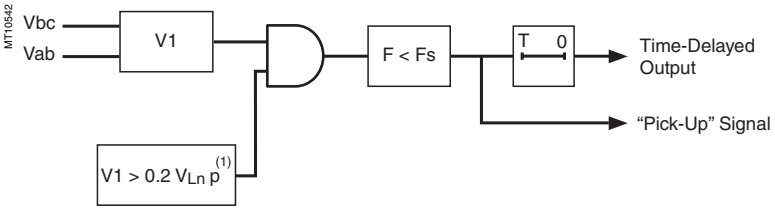
Overfrequency
ANSI Code 81H or 81O

Operation

The protection function picks up when the positive sequence voltage frequency is above the set point and the positive sequence voltage is more than 20% of $V_{Ln}p$ ($V_{LL}p/\sqrt{3}$).

If a single VT is connected (Vab), the function picks up when the frequency is higher than the set point and the Vab voltage is more than 20% of $V_{LL}p$. This VT includes a definite time delay (T).

Block Diagram



(1) *Or Vab > 0.2 V_{LL} p if only one VT.*

If there is only one sensor (Vab), the voltage signal is connected to terminals 1 and 2 of the connector CCT640, irrespective of phase.

Characteristics

Fs Set Point	
Setting	50–53 Hz or 60–63 Hz
Resolution	0.1 Hz
Accuracy (1)	±0.1 Hz
Pick-Up/Drop-Out Difference	0.2 Hz ±0.1 Hz
Time Delay (T)	
Setting	100 ms to 300 s
Accuracy (1)	±2% or ±25 ms
Resolution	10 ms or 1 Digit
Characteristic Times (1)	
Operation Time	Pick-Up < 100 ms (Typically 80 ms)
Overshoot Time	< 100 ms
Reset Time	< 100 ms

(1) *In reference conditions (IEC 60255-6) and df/dt < 3 Hz/s.*

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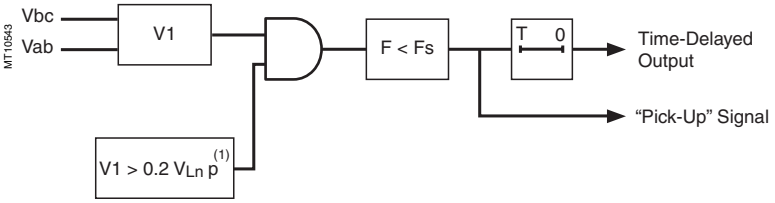
Underfrequency
ANSI Code 81L or 81U

Operation

The function picks up when the positive sequence voltage frequency is below the set point and if the negative sequence voltage is more than 20% of $V_{Ln}p$ ($V_{LL}p/\sqrt{3}$). If a single VT is connected (Vab), the function picks up when the frequency is below the set point and the Vab voltage is more than 20% of $V_{LL}p$. It also includes a definite time delay (T).

Block diagram



(1) *Or Vab > 0.2 V_{LL} p if only one VT.*

If there is only one sensor (Vab), the voltage signal is connected to terminals 1 and 2 of the connector CCT640, irrespective of phase.

Characteristics

Fs Set Point	
Setting	45–50 Hz or 55–60 Hz
Resolution	0.1 Hz
Accuracy (1)	±0.1 Hz
Pick-Up/Drop-Out Difference	0.2 Hz ±0.1 Hz
Time Delay (T)	
Setting	100 ms to 300 s
Accuracy (1)	±2% or ±25 ms
Resolution	10 ms or 1 Digit
Characteristic Times (1)	
Operation Time	Pick-Up < 100 ms (Typically 80 ms)
Overshoot Time	< 100 ms
Reset Time	< 100 ms

(1) *In reference conditions (IEC 60255-6) and df/dt < 3 Hz/s.*

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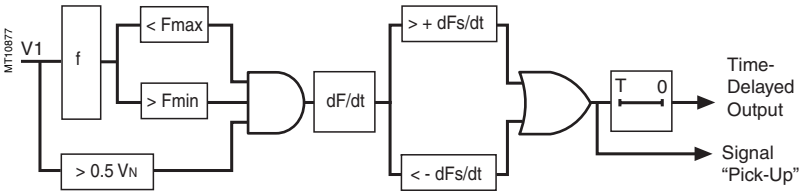
Rate of Change of Frequency
ANSI Code 81R

Operation

This function picks up when the rate of change of frequency (df/dt) of the positive sequence voltage overshoots the set point. If only one VT is connected (Vab), the function is blocked. This function includes a definite time delay (T).

Block Diagram



Characteristics

dFs/dt Set Point		
Setting		0.1–10 Hz/s
Resolution		0.1 Hz/s
Accuracy	Tripping	±5% or ±0.1 Hz/s
	No Tripping	±3% or ±0.05 Hz/s
Time Delay (T)		
Setting		100 ms to 300 s
Accuracy		±2% or ±25 ms
Resolution		10 ms or 1 Digit
Characteristic Times (1)		
Operation Time		Pick-Up < 170 ms (130 ms Typical)
Overshoot Time		< 100 ms
Reset Time		< 100 ms

(1) *In reference conditions (IEC 60255-6).*

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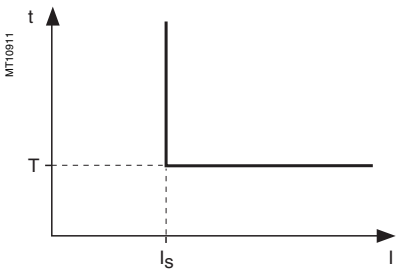
General
Tripping Curves

Presentation of tripping curve operation and settings for protection functions using:
- *Definite Time*
- *Inverse Definite Minimum Time*
- *Timer Hold*

Definite Time Protection

The tripping time is constant, and the time delay is started when the set point is exceeded.



Definite Time Protection Principle

Inverse Definite Minimum Time Protection

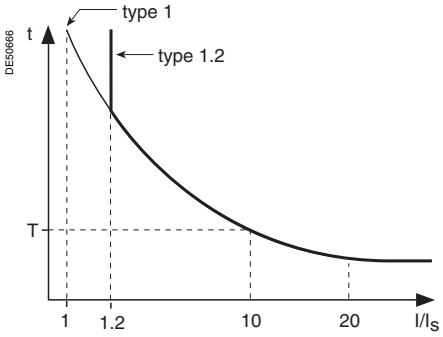
The operation time depends on the protected value (phase current, ground fault current, etc.) in accordance with standards IEC 60255-3, BS 142, and IEEE C-37112.

Operation is represented by a characteristic curve, e.g.:
- t = f(I) curve for the **phase overcurrent** function
- t = f(Ir) curve for the **ground fault** function

Note: *The rest of the document is based on t = f(I); the reasoning may be extended to other variables Ir, etc.*

The curve is defined by:
- Its type (standard inverse, very inverse, extremely inverse, etc.)
- The current setting (Is) which corresponds to the vertical asymptote of the curve
- The time delay (T) which corresponds to the operation time for I = 10 Is

These three settings are made in the following order: type, current (Is), and time delay (T). Changing the time delay (T) setting by x% changes all of the operation times in the curve by x%.



Inverse Definite Minimum Time Protection Principle

Note: *The tripping time for I/Is values less than 1.2 depends on the type of curve selected.*

Name of Curve	Type
Standard Inverse Time (SIT)	1.2
Very Inverse Time (VIT or LTI)	1.2
Extremely Inverse Time (EIT)	1.2
Ultra Inverse Time (UIT)	1.2
RI Curve	1
IEC Inverse Time SIT / A	1
IEC Very Inverse Time VIT or LTI / B	1
IEC Extremely Inverse Time EIT / C	1
IEEE Moderately Inverse (IEC / D)	1
IEEE Very Inverse (IEC / E)	1
IEEE Extremely Inverse (IEC / F)	1
IAC Inverse	1
IAC Very Inverse	1
IAC Vxtremely Inverse	1

- When the monitored value is more than 20 times the set point, the tripping time is limited to the value corresponding to 20 times the set point
- If the monitored value exceeds the measurement capacity of Sepam™ relay (40 In for the phase current channels, 20 Inr for the residual current channels), the tripping time is limited to the value corresponding to the largest measurable value (40 In or 20 Inr)

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Current Inverse Definite Minimum Time Tripping Curves

Multiple Inverse Definite Minimum Time (IDMT) tripping curves are offered, to cover most applications:

- IEC curves (SIT, VIT/LTI, EIT)
- IEEE curves (MI, VI, EI)
- Commonly used curves (UIT, RI, IAC)

IEC curves

Equation	Curve Type	Coefficient Values		
		k	α	β
$t_d(I) = \frac{k}{\left(\frac{I}{I_s}\right)^{\alpha} - 1} \times \frac{T}{\beta}$	Standard Inverse / A	0.14	0.02	2.97
	Very Inverse / B	13.5	1	1.50
	Long Time Inverse / B	120	1	13.33
	Extremely Inverse / C	80	2	0.808
	Ultra Inverse	315.2	2.5	1

RI Curve

Equation:

$$t_d(I) = \frac{1}{0.339 - 0.236\left(\frac{I}{I_s}\right)^{-1}} \times \frac{T}{3.1706}$$

IEEE Curves

Equation	Curve Type	Coefficient Values			
		A	B	p	β
$t_d(I) = \left(\frac{A}{\left(\frac{I}{I_s}\right)^{p} - 1} + B\right) \times \frac{T}{\beta}$	Moderately Inverse	0.010	0.023	0.02	0.241
	Very Inverse	3.922	0.098	2	0.138
	Extremely Inverse	5.64	0.0243	2	0.081

IAC Curves

Equation	Curve Type	Coefficient Values					
		A	B	C	D	E	β
$t_d(I) = \left(A + \frac{B}{\left(\frac{I}{I_s} - C\right)} + \frac{D}{\left(\frac{I}{I_s} - C\right)^2} + \frac{E}{\left(\frac{I}{I_s} - C\right)^3}\right) \times \frac{T}{\beta}$	Inverse	0.208	0.863	0.800	-0.418	0.195	0.297
	Very Inverse	0.090	0.795	0.100	-1.288	7.958	0.165
	Extremely Inverse	0.004	0.638	0.620	1.787	0.246	0.092

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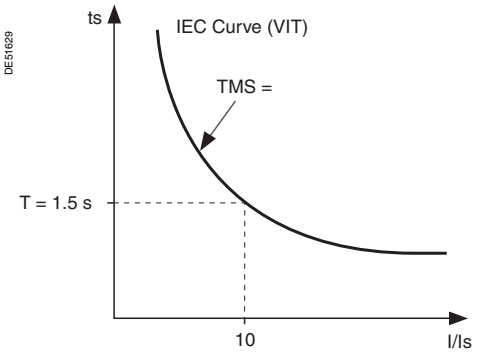


Example

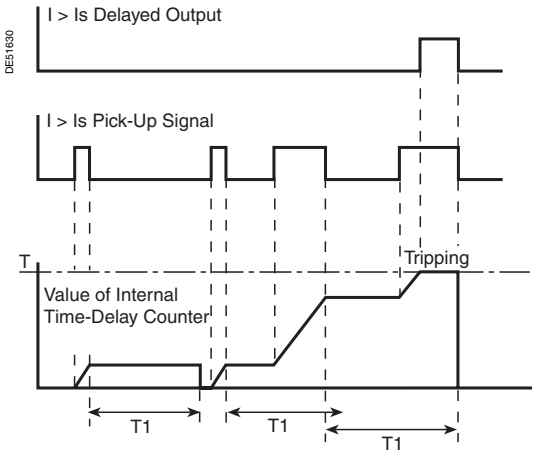
Setting of Inverse Definite Minimum Time Tripping Curves, Time Delay T or TMS Factor

The time delays of current Inverse Definite Minimum Time (IDMT) tripping curves (except for customized and RI curves) may be set as follows:

- Time (T), operating time at 10 x Is
- TMS factor, factor shown as T/β in the equations on the left

Example: $t(I) = \frac{13.5}{\frac{I}{I_s} - 1} \times TMS$ where $TMS = \frac{T}{1.5}$.

Note: *The IEC curve of the VIT type is positioned so as to be the same with TMS = 1 or T = 1.5 s.*



Detection of Restriking Faults with Adjustable Timer Hold

Timer Hold

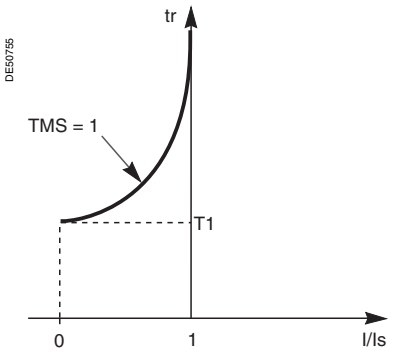
The adjustable timer hold (T1) is:

- Used to detect restriking faults (DT curve)
- Used for coordination with electromechanical relays (IDMT curve)
- May be blocked, if necessary

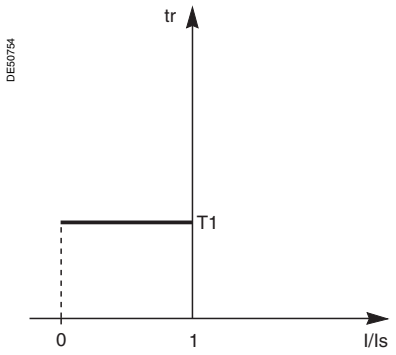
Equation for IDMT Timer Hold Curve

Equation: $t_r(I) = \frac{T1}{1 - \left(\frac{I}{I_s}\right)^2} \times \frac{T}{\beta}$ where $\frac{T}{\beta} = TMS$.

T1 = Timer hold setting (timer hold for I reset = 0 and TMS = 1)
T = Tripping time delay setting (at 10 Is)
β = Basic tripping curve value at $\frac{k}{10^{\alpha} - 1}$



Timer Hold Dependent on Current I



Constant Timer Hold

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Implementing Inverse Definite Minimum Time Curves: Examples of Problems to be Solved.

Problem 1
Given the type of inverse definite minimum time (IDMT), determine the Is current and time delay (T) settings.

Theoretically, the Is current setting corresponds to the maximum continuous current. It is generally the rated current of the protected equipment (cable, transformer).

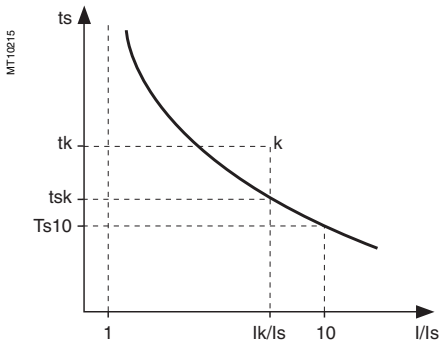
The time delay (T) corresponds to operation at 10 Is on the curve. This setting is determined while accounting for the constraints involved with the upstream and downstream protection devices.

The discrimination constraint leads to the definition of point A on the operation curve (IA, tA), e.g. the point that corresponds to the maximum fault current for the downstream protection device.

Problem 2
Given the type of inverse definite minimum time (IDMT), the Is current setting and a point k (Ik, tk) on the operation curve, determine the time delay setting (T).
On the standard curve of the same type, read the operation time (tsk) that corresponds to the relative current (Ik/Is) and the operation time (Ts10) that corresponds to the relative current (**I/Is = 10**).

The time delay setting to be used so that the operation curve passes through the point k (Ik, tk) is:

$$T = T_s 10 \times \frac{tk}{tsk}$$



Another Practical Method:
the *Table of k Values*, on page 64, gives the values of **K = ts/ts10** as a function of **I/Is.**

In the column that corresponds to the type of time delay, read the value **K = tsk/Ts10** on the line for **Ik/Is.**

The time delay setting to be used so that the operation curve passes through point k (Ik, tk) is: **T = tk/k.**

Example
- Type of time delay: standard inverse time (**SIT**)
- Set point: Is
- A point k on the operation curve: k (3.5 Is; 4 s)

Question: What is the time delay (T) setting (operation time at 10 Is)?

Read the table, **SIT** column: Line **I/Is** = **3.5** therefore **K = 1.858**

Answer: The time delay setting is **T = 4/1.858 = 2.15 s**

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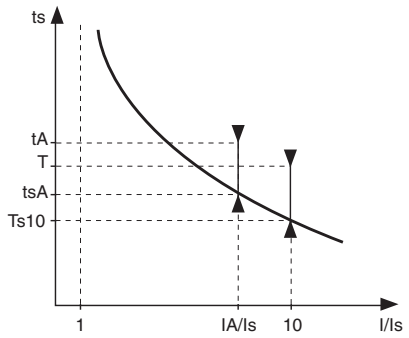
Problem 3.
Given the Is current and time delay (T) settings for a type of time delay (standard inverse, very inverse, extremely inverse), find the operation time for a current value IA.

On the standard curve of the same type, read the operation time tsA that corresponds to the relative current IA/Is and the operation time Ts10 that corresponds to the relative current **I/Is = 10.**
The operation time tA for the current IA with the Is and T settings is **tA = tsA x T/Ts10.**



Another Practical Method:
the table below gives the values of **K = ts/Ts10** as a function of **I/Is.**

In the column that corresponds to the type of time delay, read the value **K = tsA/Ts10** on the line for **IA/Is,** the operation time tA for the current IA with the Is and T settings is **tA = K . T.**

Example
- Type of time delay: very inverse time (**VIT**)
- Set point: Is
- Time delay (T): 0.8 s

Question: What is the operation time for the current IA = 6 Is?

Read the table, **VIT** column**:** line I/Is = 6, therefore k = 1.8

Answer: The operation time for the current IA is t = 1.80 x 0.8 = 1.44 s.

Table of K Values

I/Is	SIT and IEC/A	VIT, LTI, and IEC/B	EIT and IEC/C	UIT	RI	IEEE MI (IEC/D)	IEEE VI (IEC/E)	IEEE EI (IEC/F)	IAC I	IAC VI	IAC EI
1.0	—	—	—	—	3.062	—	—	—	62.005	62.272	200.226
1.1	24.700 (1)	90.000 (1)	471.429 (1)	—	2.534	22.461	136.228	330.606	19.033	45.678	122.172
1.2	12.901	45.000	225.000	545.905	2.216	11.777	65.390	157.946	9.413	34.628	82.899
1.5	5.788	18.000	79.200	179.548	1.736	5.336	23.479	55.791	3.891	17.539	36.687
2.0	3.376	9.000	33.000	67.691	1.427	3.152	10.199	23.421	2.524	7.932	16.178
2.5	2.548	6.000	18.857	35.490	1.290	2.402	6.133	13.512	2.056	4.676	9.566
3.0	2.121	4.500	12.375	21.608	1.212	2.016	4.270	8.970	1.792	3.249	6.541
3.5	1.858	3.600	8.800	14.382	1.161	1.777	3.242	6.465	1.617	2.509	4.872
4.0	1.676	3.000	6.600	10.169	1.126	1.613	2.610	4.924	1.491	2.076	3.839
4.5	1.543	2.571	5.143	7.513	1.101	1.492	2.191	3.903	1.396	1.800	3.146
5.0	1.441	2.250	4.125	5.742	1.081	1.399	1.898	3.190	1.321	1.610	2.653
5.5	1.359	2.000	3.385	4.507	1.065	1.325	1.686	2.671	1.261	1.473	2.288
6.0	1.292	1.800	2.829	3.616	1.053	1.264	1.526	2.281	1.211	1.370	2.007
6.5	1.236	1.636	2.400	2.954	1.042	1.213	1.402	1.981	1.170	1.289	1.786
7.0	1.188	1.500	2.063	2.450	1.033	1.170	1.305	1.744	1.135	1.224	1.607
7.5	1.146	1.385	1.792	2.060	1.026	1.132	1.228	1.555	1.105	1.171	1.460
8.0	1.110	1.286	1.571	1.751	1.019	1.099	1.164	1.400	1.078	1.126	1.337
8.5	1.078	1.200	1.390	1.504	1.013	1.070	1.112	1.273	1.055	1.087	1.233
9.0	1.049	1.125	1.238	1.303	1.008	1.044	1.068	1.166	1.035	1.054	1.144
9.5	1.023	1.059	1.109	1.137	1.004	1.021	1.031	1.077	1.016	1.026	1.067
10.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10.5	0.979	0.947	0.906	0.885	0.996	0.981	0.973	0.934	0.985	0.977	0.941
11.0	0.959	0.900	0.825	0.787	0.993	0.963	0.950	0.877	0.972	0.957	0.888
11.5	0.941	0.857	0.754	0.704	0.990	0.947	0.929	0.828	0.960	0.939	0.841
12.0	0.925	0.818	0.692	0.633	0.988	0.932	0.912	0.784	0.949	0.922	0.799
12.5	0.910	0.783	0.638	0.572	0.985	0.918	0.896	0.746	0.938	0.907	0.761
13.0	0.895	0.750	0.589	0.518	0.983	0.905	0.882	0.712	0.929	0.893	0.727
13.5	0.882	0.720	0.546	0.471	0.981	0.893	0.870	0.682	0.920	0.880	0.695
14.0	0.870	0.692	0.508	0.430	0.979	0.882	0.858	0.655	0.912	0.868	0.667
14.5	0.858	0.667	0.473	0.394	0.977	0.871	0.849	0.631	0.905	0.857	0.641
15.0	0.847	0.643	0.442	0.362	0.976	0.861	0.840	0.609	0.898	0.846	0.616
15.5	0.836	0.621	0.414	0.334	0.974	0.852	0.831	0.589	0.891	0.837	0.594
16.0	0.827	0.600	0.388	0.308	0.973	0.843	0.824	0.571	0.885	0.828	0.573
16.5	0.817	0.581	0.365	0.285	0.971	0.834	0.817	0.555	0.879	0.819	0.554
17.0	0.808	0.563	0.344	0.265	0.970	0.826	0.811	0.540	0.874	0.811	0.536
17.5	0.800	0.545	0.324	0.246	0.969	0.819	0.806	0.527	0.869	0.804	0.519
18.0	0.792	0.529	0.307	0.229	0.968	0.812	0.801	0.514	0.864	0.797	0.504
18.5	0.784	0.514	0.290	0.214	0.967	0.805	0.796	0.503	0.860	0.790	0.489
19.0	0.777	0.500	0.275	0.200	0.966	0.798	0.792	0.492	0.855	0.784	0.475
19.5	0.770	0.486	0.261	0.188	0.965	0.792	0.788	0.482	0.851	0.778	0.463
20.0	0.763	0.474	0.248	0.176	0.964	0.786	0.784	0.473	0.848	0.772	0.450

(1) *Values only suitable for IEC A, B and C curves.*

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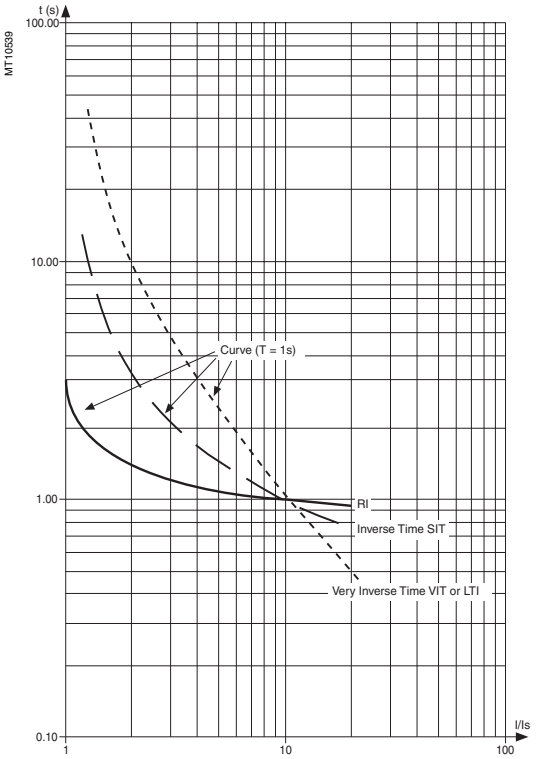
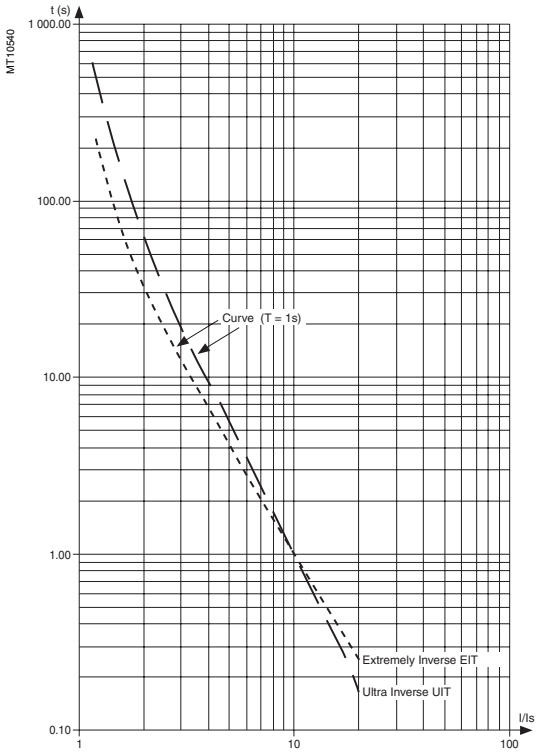
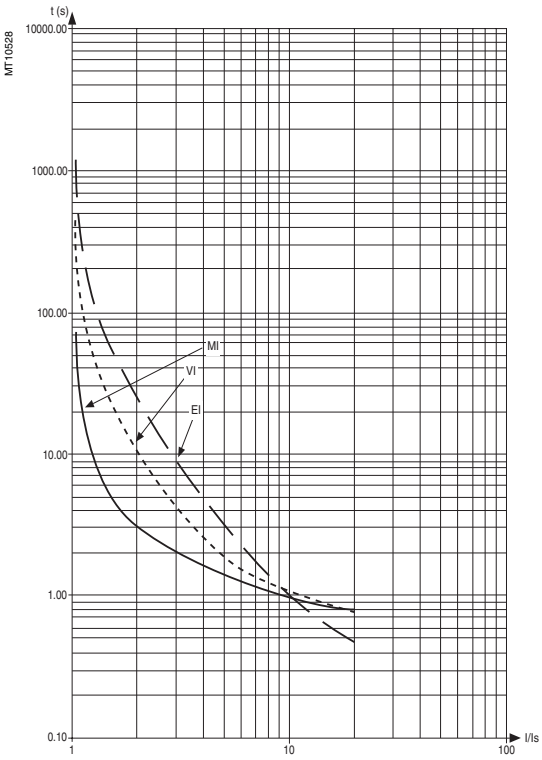
Standard Inverse Time (SIT) Curve
Very Inverse Time (VIT or LTI) Curve
RI Curve



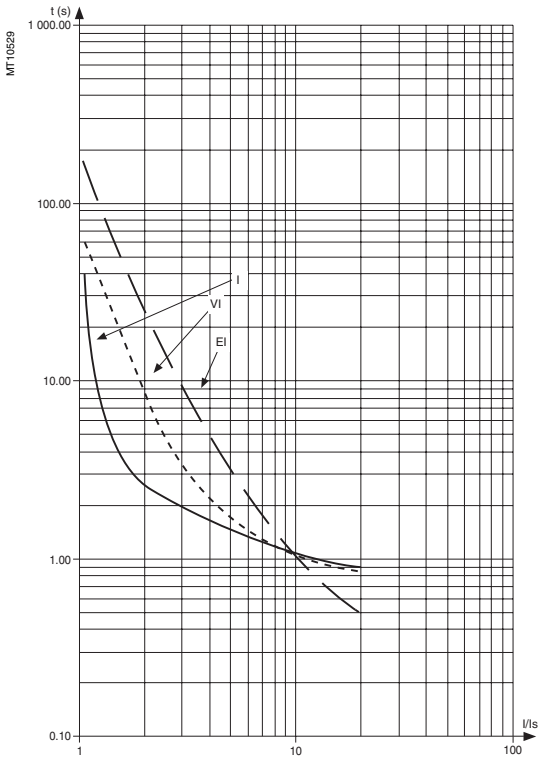
Extremely Inverse Time (EIT) Curve
Ultra Inverse Time (UIT) Curve



IEEE Curves



IAC Curves



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Description

Sepam™ relays perform the control and monitoring functions necessary for proper electrical network operation.

Predefined Functions

The main control and monitoring functions are predefined and designed for the most commonly used applications. They are easily commissioned by simply setting a few device parameters, after the necessary logic inputs/outputs have been assigned. The predefined control and monitoring functions can be adapted for particular applications by customizing the control matrix with the SFT2841 software.

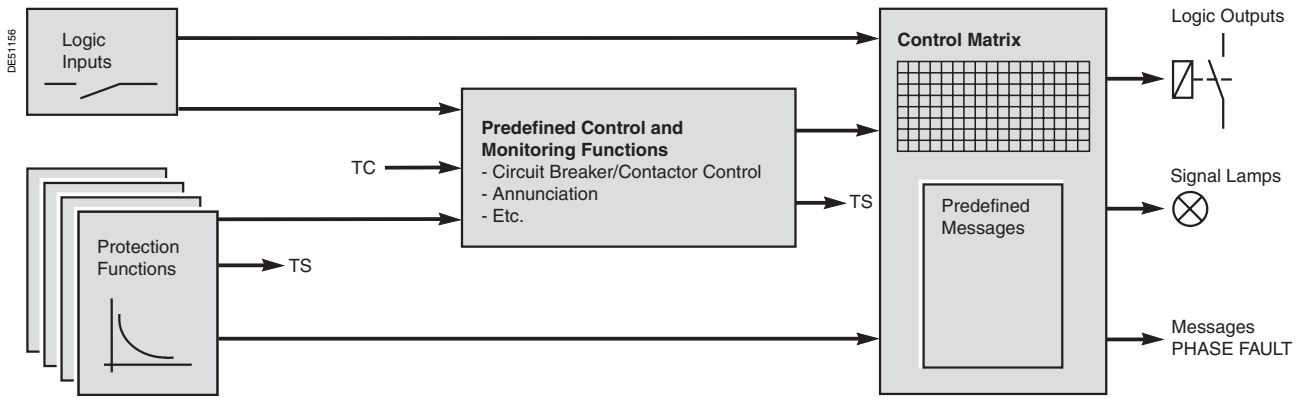
Control Matrix

The control matrix is a simple way to arrange data from:
- Protection Functions
- Predefined Control and Monitoring Functions
- Logic Inputs

To the following outputs:
- Output Relays
- Nine LEDs on the Front Panel of Sepam Relays
- Triggering of Disturbance Recording

Operating Principle

The processing of each control and monitoring function can be divided into three phases:
- Acquisition of Input Data:
  - Results of protection function processing
  - External logic data, connected to the logic inputs of an optional MES114 input / output module
  - Remote control command (TC) received via the communication link
- Actual Processing of the Control and Monitoring Function
- Utilization of the Processing Results:
  - Activation of output relays to control an actuator
  - Information sent to the facility manager:
    - By message and/or LED on the Sepam display and SFT2841 software
    - By remote indication (TS) via the communication link



Logic Inputs and Outputs

The number of Sepam relay logic inputs/outputs must be adapted to fit the control and monitoring functions used. The number of logic outputs in a Sepam Series 20 relay (four outputs included standard) can be expanded by adding a MES114 module with an additional ten inputs and four outputs. After selecting the MES114 type required by an application, the logic inputs must be assigned to functions.

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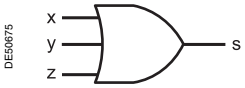
Definition of Symbols

The symbols used in the different block diagrams describing the control and monitoring functions are defined on this page.

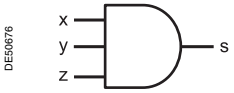
Logic Functions

■ **"OR"**



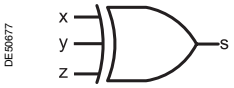
Equation: $s = x + y + z$

■ **"AND"**



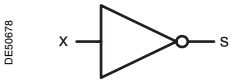
Equation: $s = x \cdot y \cdot z$

■ **Exclusive "XOR"**



s = 1 if one and only one input is set to 1
($s = 1$ if $x + y + z = 1$)

■ **Complement**
These functions may use the complement of one or more input values.

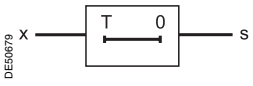


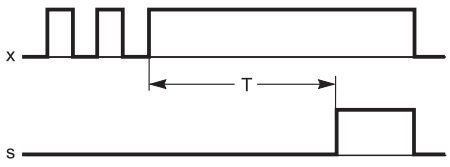
Equation: $S = \bar{x}$ (S = 1 if x = 0)

Delay Timers

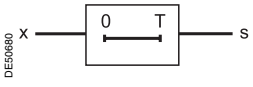
Two types of delay timers:

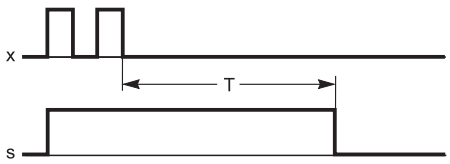
■ "On" delay timer: used to delay the appearance of a signal by a time T





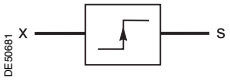
■ "Off" delay timer: used to delay the disappearance of a signal by a time T

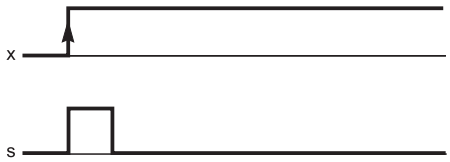




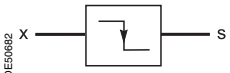
Pulse Mode Operation

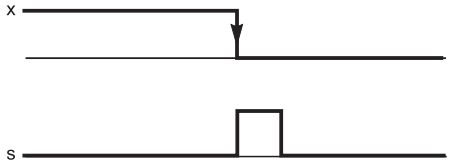
□"On" Pulse:
Used to create a short-duration pulse (1 cycle) each time a signal appears





■ "Off" Pulse:
Used to create a short-duration pulse (1 cycle) each time a signal disappears

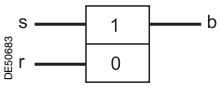


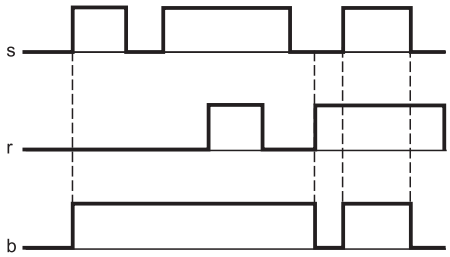


Note: *the disappearance of a signal may be caused by an auxiliary power failure.*

Bistable Functions

Bistable functions may be used to store values.





Equation: $b = s + \bar{r} \cdot b$

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Assignment of Logic Inputs/Outputs

Before using the preset control and monitoring functions, set the parameters and wire the inputs according to their application and type of Sepam™ relay. Use the advanced UMI or the SFT2841 software to assign inputs and set the control and monitoring function parameters.

Note: *Since an input may only be assigned to a single function, not all the functions are available at the same time.*

For example, if the zone selective interlocking function is used, the switching groups of settings function may not be used.

Table of Input/Output Assignment by Application

Functions	S20	S23	T20	T23	M20	B21 - B22	Assignment
Logic inputs							
Open Position	■	■	■	■	■	■	I11
Closed Position	■	■	■	■	■	■	I12
Zone Selective Interlocking, Receive Blocking Input	■	■	■	■			I13
Switching of Groups of Settings A/B	■	■	■	■	■		
External Reset	■	■	■	■	■	■	I14
External Tripping 4 (1)	■	■	■	■	■	■	
External Tripping 1 (1)	■	■	■ (2)	■ (2)	■	■	I21
External Network Synchronization	■	■	■	■	■	■	
External Tripping 2 (1)	■	■	■ (3)	■ (3)	■	■	I22
Motor Re-Acceleration					■		
External Tripping 3 (1)	■	■	■ (4)	■ (4)	■	■	I23
Buchholz Alarm (1) (Buchholz Alarm Message)			■	■			
Rotor Rotation Detection					■		
Thermistor Tripping (1)			■	■	■		
Block Ground Fault Protection		■					
End of Charging Position	■	■	■	■	■		I24
Thermostat Alarm (1) (Thermostat Alarm Message)			■	■			
Thermistor Alarm (1)			■	■	■		
External Tripping 5 and 50BF Activation.		■		■			
Block Remote Control, Excluding TC1 (1)	■	■	■	■	■	■	I25
Block remote control, Including TC1 (1)	■	■	■	■	■	■	
SF6-1	■	■	■	■	■	■	
SF6-2	■	■	■	■	■	■	I26
Change of Thermal Settings			■	■	■		
Block Thermal Overload			■	■	■		
Block Recloser	■	■					
Logic Outputs							
Tripping	■	■	■	■	■	■	O1
Block Closing	■	■	■	■	■	■	O2
Watchdog	■	■	■	■	■	■	O4
Close Command	■	■	■	■	■	■	O11

Note: *All of the logic inputs are available via the communication link and are accessible in the SFT2841 control matrix for other applications that aren't predefined.*

(1) *These inputs have a parameter setting with the prefix "NEG" for undervoltage operation.*
(2) *Buchholz/Gas trip message.*
(3) *Thermostat trip message.*
(4) *Pressure trip message.*

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Circuit Breaker/Contactor Control

Description

Sepam™ relays can be used to control breaking devices equipped with different types of closing and tripping coils:

- Circuit breakers with normally open (N.O.) or normally closed (N.C.) contacts (parameter set on the front of the advanced UMI or in SFT2841)
- Latching contactors with normally closed contacts

Two breaking device control modes are available:

- Use of the operating mechanism integrated in the circuit breaker/contactor to process all circuit breaker closing and tripping conditions based on:
  - Breaking device status information
  - Remote control operation
  - Protection functions
  - Specific program logic for each application (e.g. recloser)

  Note: *This function also blocks closing of the breaking device according to the operating conditions.*

- Use of customized program logic with a control and monitoring resource assignment matrix

Operating Mechanism Integrated in the Circuit Breaker/Contactor

For operation in accordance with the block diagram, the Sepam relay must have the required logic inputs (therefore, an MES114 module must be included), and the related parameters set and wiring done.

Remote control

Circuit breaker/contactor tripping can be controlled remotely via the communication link using the following remote control commands:

- TC1: Circuit breaker/contactor tripping
- TC2: Circuit breaker/contactor closing
- TC5: Sepam relay acknowledgment (reset)

These commands can be blocked globally by logic input I25. According to the parameter setting of logic input I25, the tripping remote control TC1 can be activated or blocked at any time.

Circuit Breaker/Contactor Control with Lockout Function (ANSI 86)

The ANSI 86 function, traditionally performed by lockout relays, can be performed by a Sepam relay using the predefined Circuit breaker/contactor control function (including latching of all tripping conditions — protection function outputs and logic inputs).

With this function, Sepam relays do the following:

- Group all tripping conditions and breaking device control
- Latch the tripping command with closing linked until the cause of tripping ceases and is acknowledged by the user (see "Latching/Acknowledgment" on page 73)
- Indicate the cause of tripping:
  - Locally, by signal lamps ("Trip" and others) and by messages on the display
  - Remotely, by remote indications

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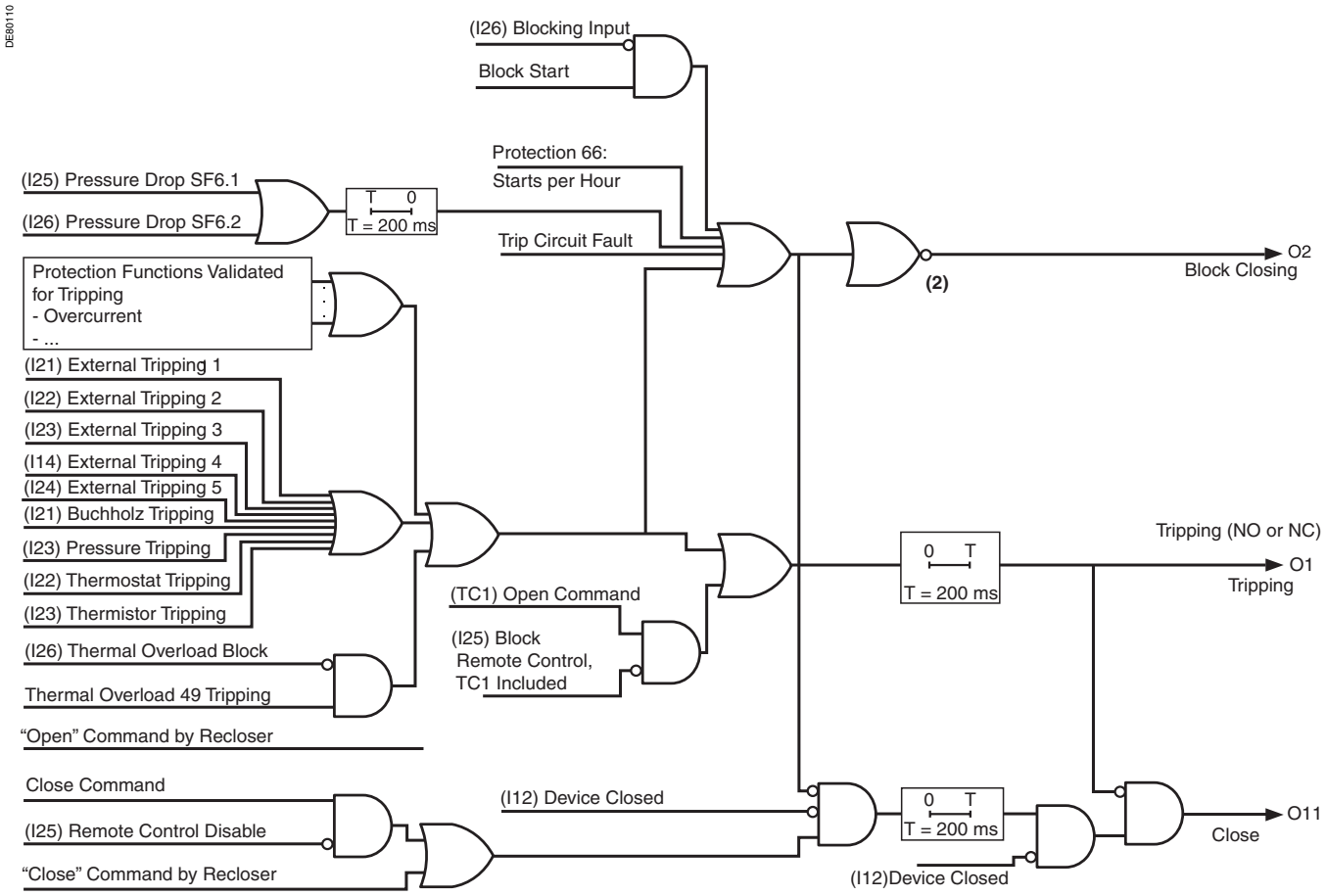
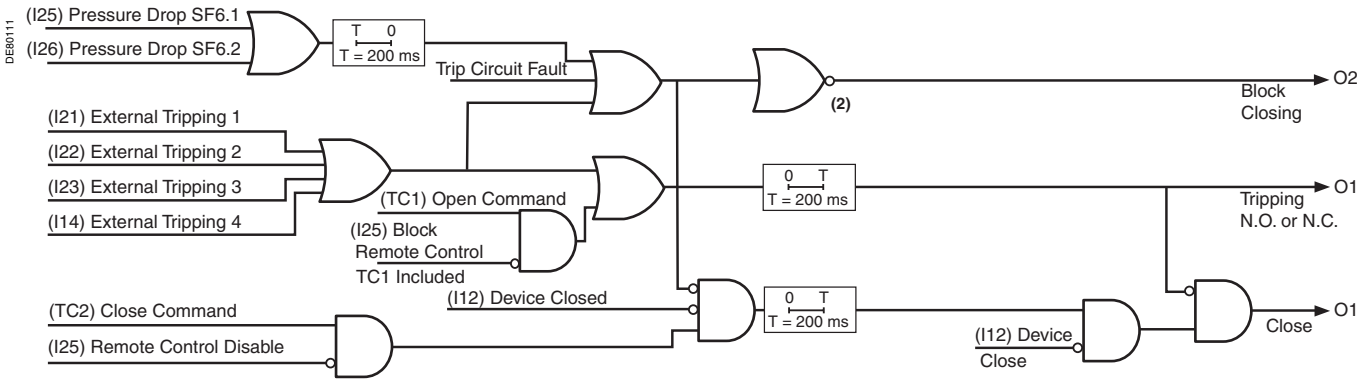
Block Diagram (1): Sepam™ S20, S23, T20, T23 or M20



Block Diagram (1): Sepam B21 (3) or B22



(1) *Data used in the logic block diagram depend on the Sepam type, availability of the MES114 option, and general parameters.*
(2) *The usual case, in which O2 is set to Normally closed.*
(3) *Performs B20 type functions.*

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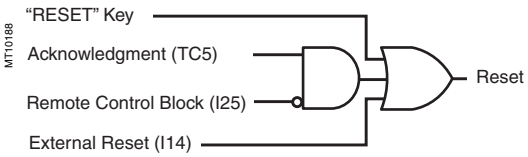
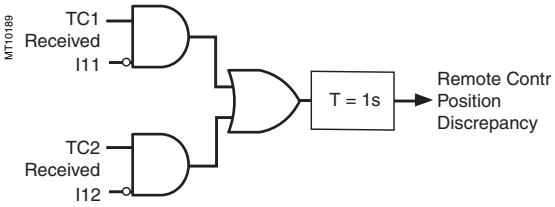


Latching/Acknowledgment

The tripping outputs of the protection functions and logic inputs can be latched individually (logic outputs cannot be latched). The logic outputs set up in pulse mode maintain pulse-type operation, even when linked to latched data.

Note: *Latched data are saved in the event of a power failure.*

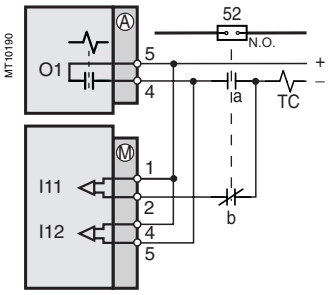
All latched data can be acknowledged locally on the UMI, or remotely by a logic input or the communication link. The "Latching/Acknowledgment" function associated with the "Circuit Breaker/Contactor Control" function may be used to perform the ANSI 86 "Lockout Relay" function.



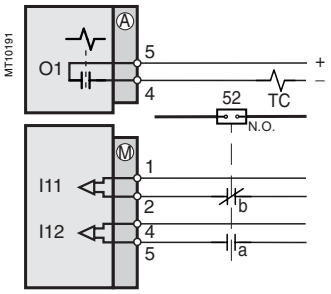
TC/Circuit Breaker Position Discrepancy

This function detects a discrepancy between the last remote control command received and the actual position of the circuit breaker.

Note: *The information is accessible via remote indication TS42.*



Wiring for normally open trip circuits



Wiring for undervoltage trip unit

Trip Circuit Supervision and Open/Closed Matching

Description

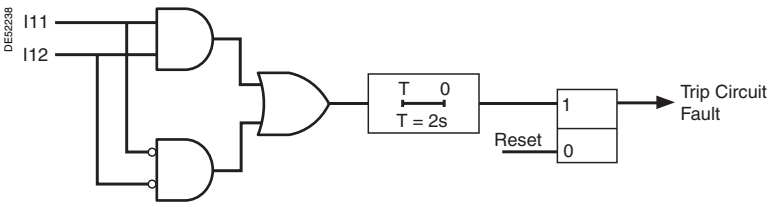
This supervision is designed for trip circuits:

- With normally open trip circuits, the function detects:
  - Circuit continuity
  - Loss of supply
  - Mismatching of position contacts

  Note: *The function blocks closing of the breaking device.*
- With undervoltage trip units

The function detects mismatched position contacts, with coil supervision unnecessary in this case. The information is accessible in the matrix and via the remote indication TS43.

Block Diagram (1)



(1) *With MES option*

Note: *The function is activated if inputs I11 and I12 are set respectively as circuit breaker "open position" and circuit breaker "closed position".*

Open and Close Supervision

Following a circuit breaker open or close command, the system checks whether, after a 2 seconds time delay, the circuit breaker has actually changed status.

If the circuit breaker status does not match the last command sent, a "Control Fault" message and remote indication TS45 are generated.

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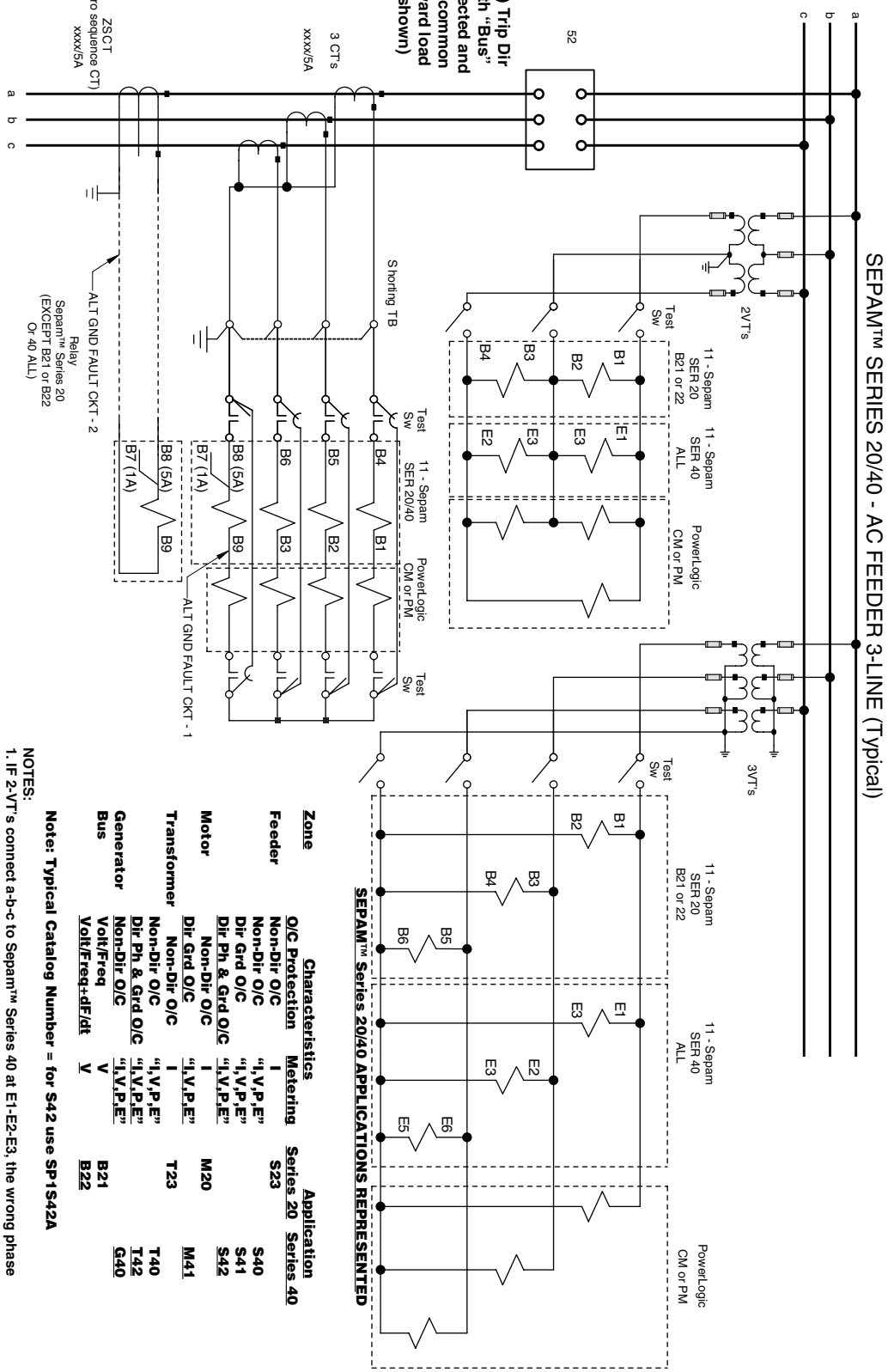
Circuit Breaker/Contactor Control
AC Feeder 3-Line (Typical)



SEPAM™ Series 20/40 APPLICATIONS REPRESENTED

Zone	Characteristics		Application	
	O/C Protection	**Metering**	**Series 20**	**Series 40**
Feeder	**Non-Dir O/C**	**I**	**S23**	**S40**
	Non-Dir O/C	**"I,V,P,E"**		**S41**
	Dir Grd O/C	**"I,V,P,E"**		**S42**
	Dir Ph & Grd O/C	**"I,V,P,E"**		
Motor	**Non-Dir O/C**	**I**	**M20**	
	Dir Grd O/C	**"I,V,P,E"**		**M41**
Transformer	**Non-Dir O/C**	**I**	**T23**	
	Non-Dir O/C	**"I,V,P,E"**		**T40**
	Dir Ph & Grd O/C	**"I,V,P,E"**		**T42**
Generator Bus	**Non-Dir O/C**	**"I,V,P,E"**		**G40**
	Volt/Freq	**V**	**B21**	
	Volt/Freq+dF/dt	**V**	**B22**	

Note: Typical Catalog Number = for S42 use SP1S42A

NOTES:
1. IF 2-VT's connect a-b-c to Sepam™ Series 40 at E1-E2-E3, the wrong phase sequence will cause "Rotation" alarm and 47 (Neg Seq O/V) operation.

63230-216-208C1
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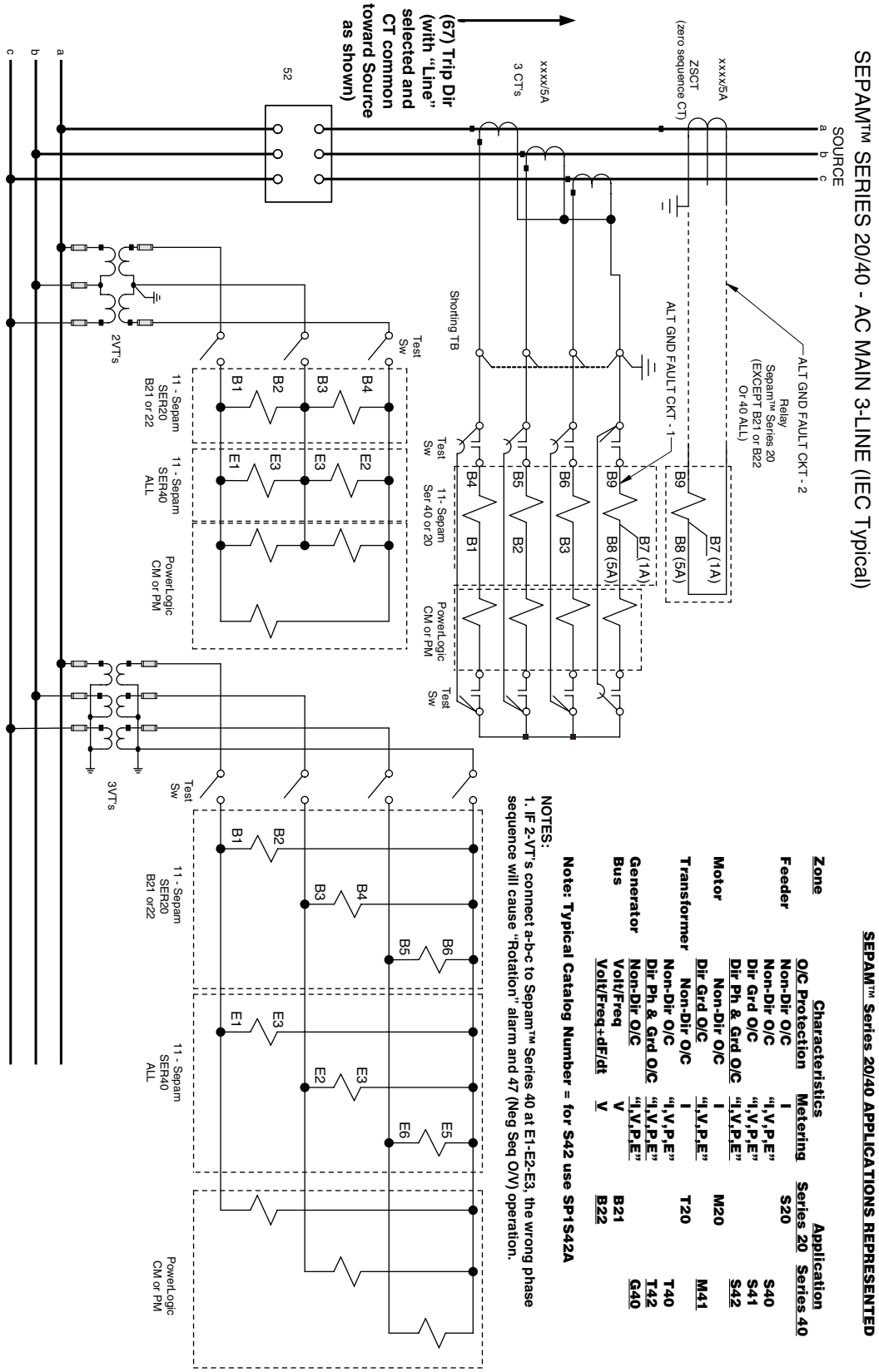

SEPAM™ Series 20/40 APPLICATIONS REPRESENTED

Zone	Characteristics		Application	
	O/C Protection	Metering	Series 20	Series 40
Feeder	Non-Dir O/C	I	S20	
	Non-Dir O/C	"I,V,P,E"		S40
	Dir Grd O/C	"I,V,P,E"		S41
	Dir Ph & Grd O/C	"I,V,P,E"		S42
Motor	Non-Dir O/C	I	M20	M41
	Dir Grd O/C	"I,V,P,E"		
Transformer	Non-Dir O/C	I	T20	
	Non-Dir O/C	"I,V,P,E"		T40
	Dir Ph & Grd O/C	"I,V,P,E"		T42
Generator	Non-Dir O/C	"I,V,P,E"		G40
Bus	Volt/Freq	V	B21	
	Volt/Freq+dF/dt	V	B22	

Note: Typical Catalog Number = for S42 use SP1S42A

NOTES:
1. IF 2-VT's connect a-b-c to Sepam™ Series 40 at E1-E2-E3, the wrong phase sequence will cause "Rotation" alarm and 47 (Neg Seq O/V) operation.

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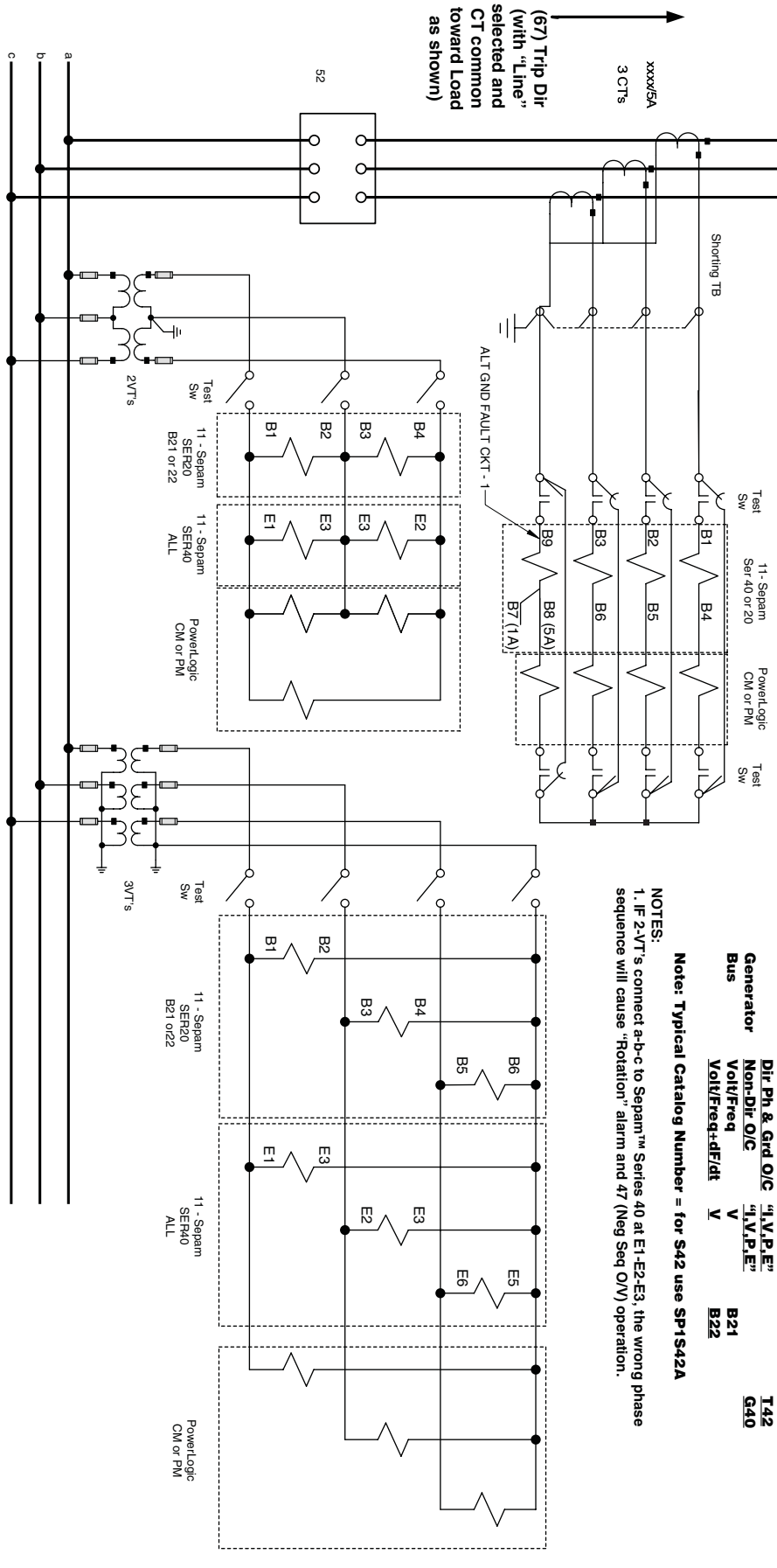
SEPAM™ SERIES 20/40 - AC MAIN 3-LINE (ANSI Typical)



SEPAM™ Series 20/40 APPLICATIONS REPRESENTED

Zone	Characteristics		Application	
	O/C Protection	Metering	Series 20	Series 40
Feeder	Non-Dir O/C	I	S20	
	Non-Dir O/C	"I,V,P,E"		S40
	Dir Grd O/C	"I,V,P,E"		S41
	Dir Ph & Grd O/C	"I,V,P,E"		S42
Motor	Non-Dir O/C	I	M20	
	Dir Grd O/C	"I,V,P,E"		M41
Transformer	Non-Dir O/C	I	T20	
	Non-Dir O/C	"I,V,P,E"		T40
	Dir Ph & Grd O/C	"I,V,P,E"		T42
Generator	Non-Dir O/C	"I,V,P,E"		G40
Bus	Volt/Freq	V	B21	
	Volt/Freq+dF/dt	V	B22	

Note: Typical Catalog Number = for S42 use SP1S42A

NOTES:
1. IF 2-VT's connect a-b-c to Sepam™ Series 40 at E1-E2-E3, the wrong phase sequence will cause "Rotation" alarm and 47 (Neg Seq O/V) operation.

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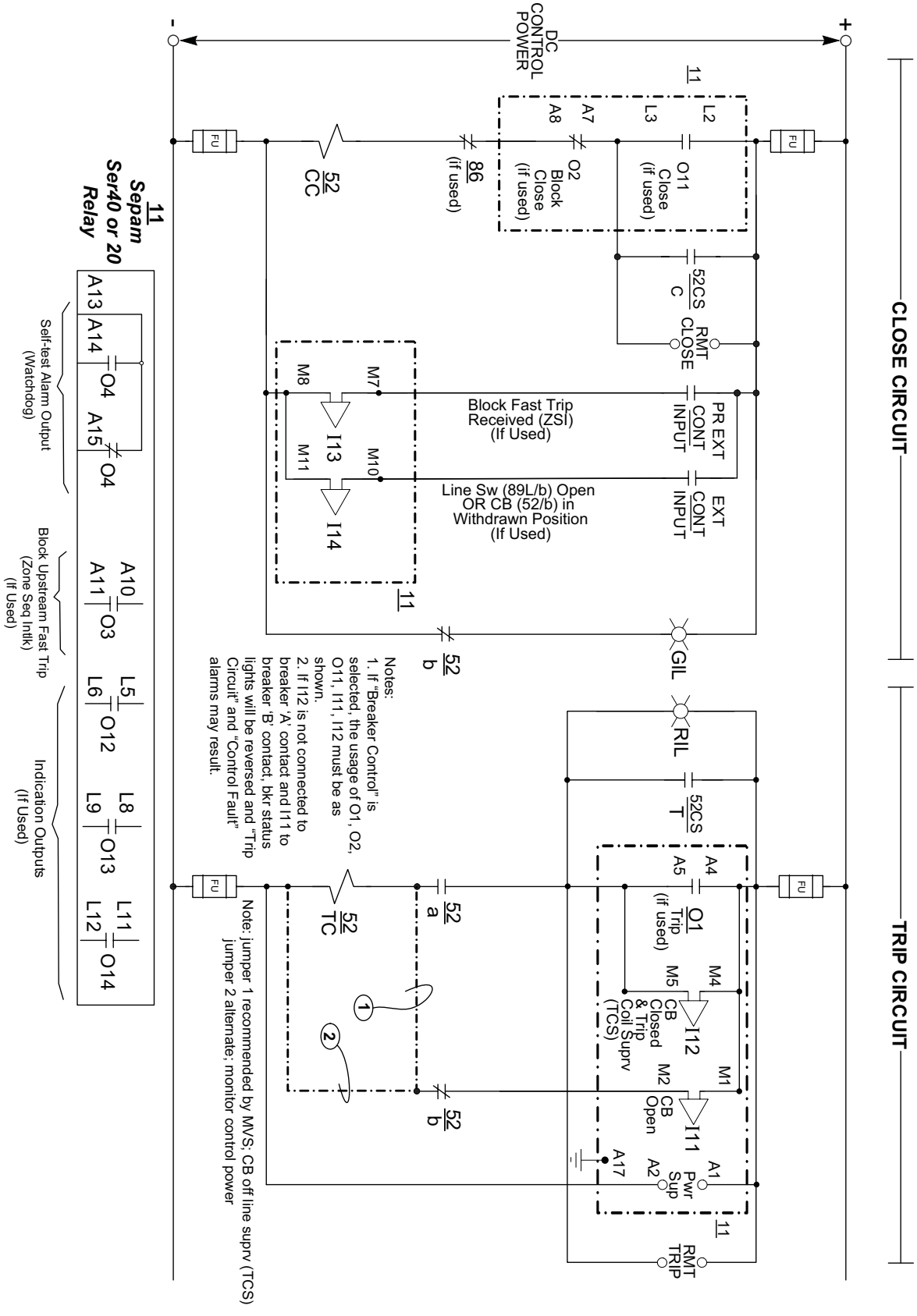

BREAKER DC CONTROL USING SEPAM™ SERIES 20/40
CLOSE CIRCUIT
TRIP CIRCUIT
DC CONTROL POWER
+
-
11
Sepam Ser40 or 20 Relay
Self-test Alarm Output (Watchdog)
Block Upstream Fast Trip (Zone Seq Intlk) (If Used)
Indication Outputs (If Used)
A13
A14
O4
A15
O4
A10
A11
O3
L5
L6
O12
L8
L9
O13
L11
L12
O14
FU
52 CC
86 (if used)
O2 Block Close (if used)
O11 Close (if used)
52CS C
RMT CLOSE
Block Fast Trip Received (ZSI) (If Used)
PR EXT CONT INPUT
Line Sw (89L/b) Open OR CB (52/b) in Withdrawn Position (If Used)
EXT CONT INPUT
M7
M8
M10
M11
I13
I14
52 b
GIL
RIL
52CS T
A4
A5
O1 Trip (if used)
M4
M5
I12
CB Closed & Trip Coil Suprv (TCS)
M1
M2
CB Open
I11
A17
A1
A2
Pwr Sup
RMT TRIP
52 a
52 TC
1
2
Notes:
1. If "Breaker Control" is selected, the usage of O1, O2, O11, I11, I12 must be as shown.
2. If I12 is not connected to breaker 'A' contact and I11 to breaker 'B' contact, bkr status lights will be reversed and "Trip Circuit" and "Control Fault" alarms may result.
Note: jumper 1 recommended by MVS; CB off line suprv (TCS) jumper 2 alternate; monitor control power

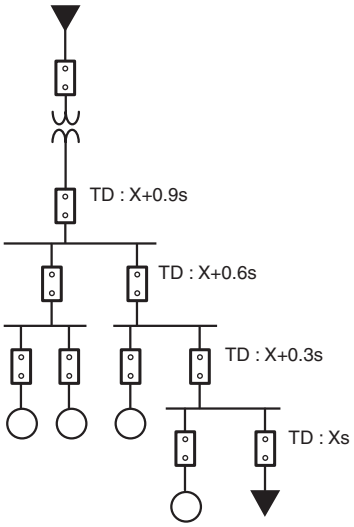
Zone Selective Interlocking
ANSI Code 68/48

Description

This function provides:
- Full tripping discrimination
- A substantial reduction in delayed tripping of the circuit breakers located nearest the source (which is a major drawback of the classical time-based discrimination process)

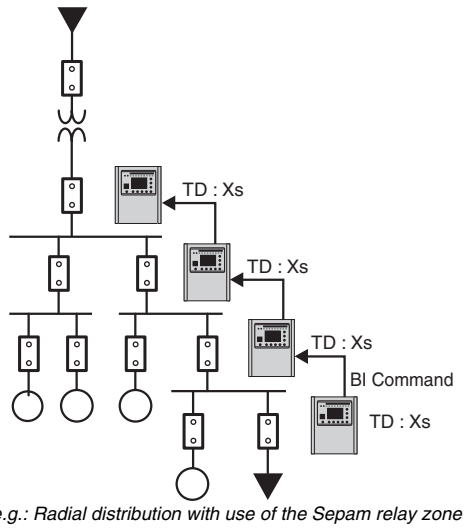
Note: *The system applies to the definite time (DT) and inverse definite minimum time (IDMT) phase overcurrent and ground fault protection functions.*

MT10196



e.g.: Radial distribution with use of time-based protection (TD: tripping time definite time curves)

MT10197

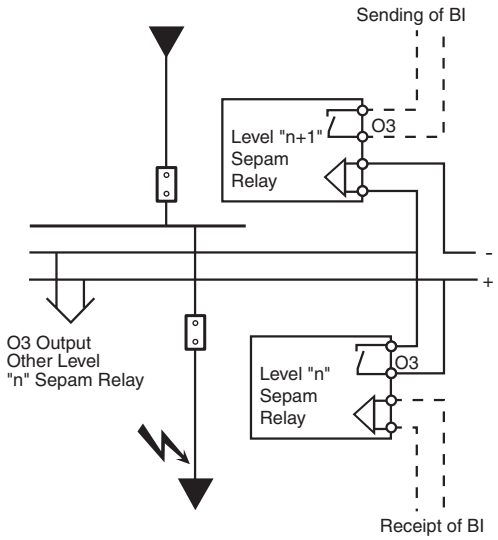


e.g.: Radial distribution with use of the Sepam relay zone selective interlocking system

With this type of system, time delays are set in accordance with the device to be protected, without consideration of the discrimination aspect.

Operating Principle

MT10195



When a fault occurs in a radial network, the fault current flows through the circuit between the source and the location of the fault:
- The protection units upstream from the fault are triggered
- The protection units downstream from the fault are not triggered
- Only the first protection unit upstream from the fault should trip
  - Each Sepam™ relay is capable of sending and receiving blocking input (BI) commands (except for motor Sepam relays **(1)**, which can only send them)

When a Sepam relay is triggered by a fault current:
- It sends a blocking input command to output O3 **(2)**
- It trips the associated circuit breaker if it does not receive a blocking input command on the blocking input logic input **(3)**

Once sent, the blocking input lasts the duration of the fault (until cleared). It is interrupted after a time delay that accounts for the breaking device operating time and protection unit reset time. This system minimizes fault duration, and optimizes discrimination.

Pilot Wire Test

The pilot wire test may be performed using the output relay test function.

(1) *Motor Sepam relays are not affected by the receipt of blocking input since they are designed for loads only.*
(2) *Default parameter setting.*
(3) *According to parameter settings and presence of an additional MES114 module.*

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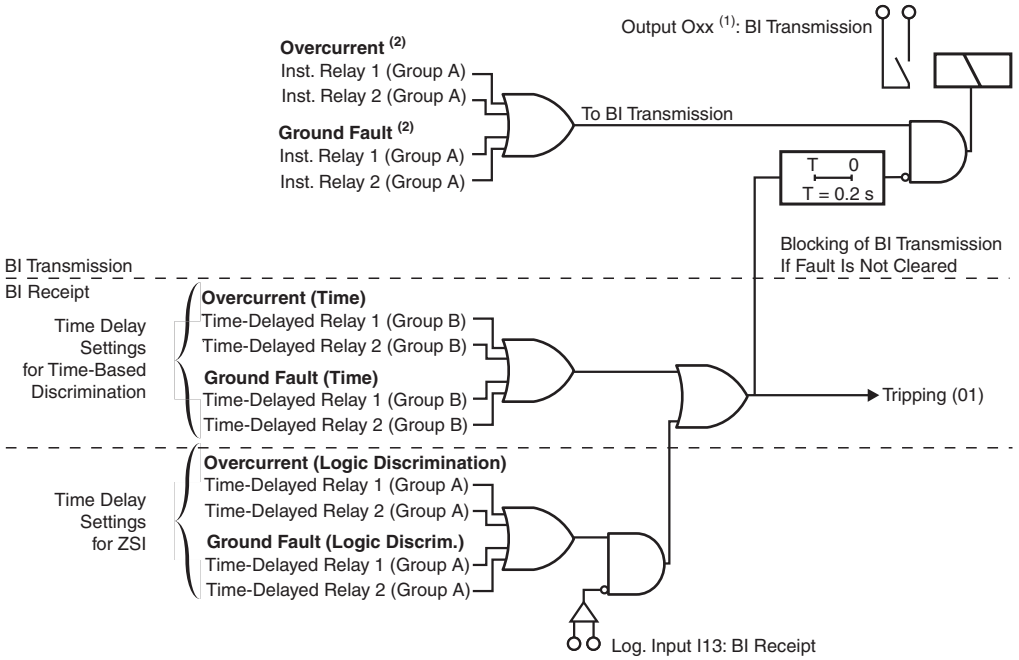
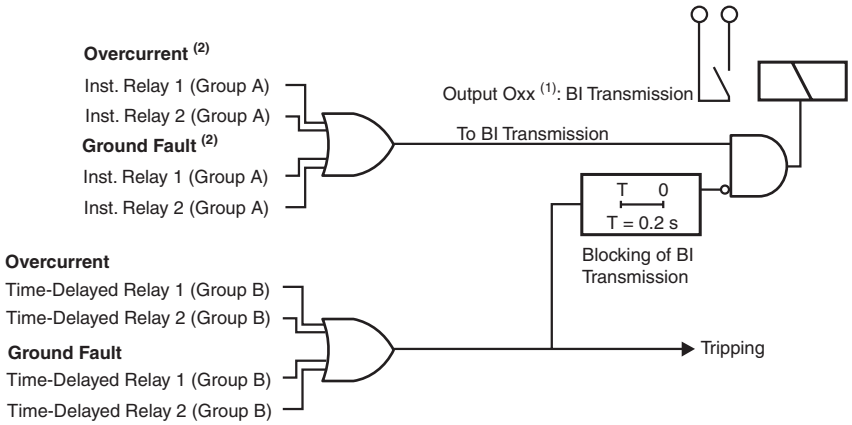
Block Diagram: Sepam™ S20, S23, T20 and T23

DE50375


Output Oxx (1): BI Transmission
Overcurrent (2)
Inst. Relay 1 (Group A)
Inst. Relay 2 (Group A)
Ground Fault (2)
Inst. Relay 1 (Group A)
Inst. Relay 2 (Group A)
To BI Transmission
T 0
T = 0.2 s
Blocking of BI Transmission
If Fault Is Not Cleared
BI Transmission
BI Receipt
Time Delay Settings for Time-Based Discrimination
Overcurrent (Time)
Time-Delayed Relay 1 (Group B)
Time-Delayed Relay 2 (Group B)
Ground Fault (Time)
Time-Delayed Relay 1 (Group B)
Time-Delayed Relay 2 (Group B)
Tripping (01)
Time Delay Settings for ZSI
Overcurrent (Logic Discrimination)
Time-Delayed Relay 1 (Group A)
Time-Delayed Relay 2 (Group A)
Ground Fault (Logic Discrim.)
Time-Delayed Relay 1 (Group A)
Time-Delayed Relay 2 (Group A)
Log. Input I13: BI Receipt

Block Diagram: Sepam M20

DE50376



(1) *According to parameter setting (O3 by default).*
(2) *Instantaneous action (inst) corresponds to protection "pick-up" signal information.*

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Disturbance Recording Triggering

Description

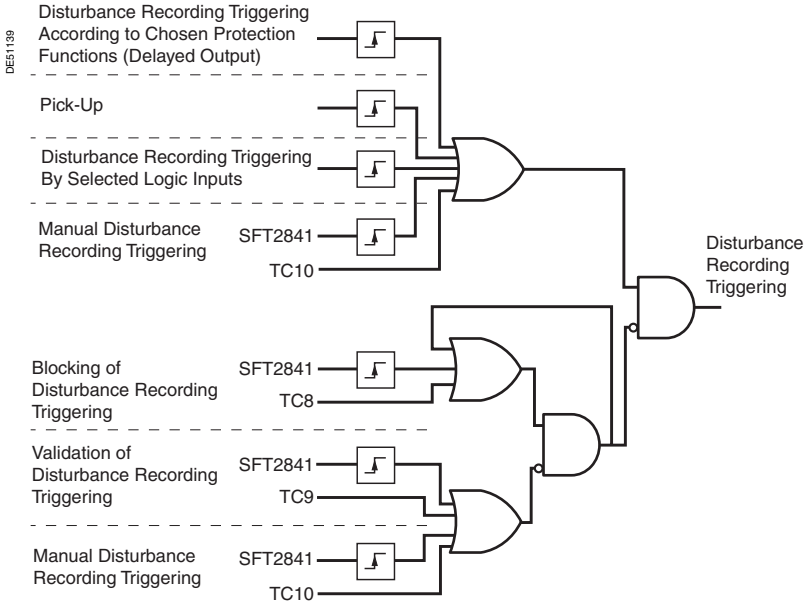
Analog and logic signals can be recorded, based on triggering events, control matrix parameter settings, or manual action:

- Triggering by the grouping of all pick-up signals of the protection functions in service
- Triggering by the delayed outputs of selected protection functions
- Triggering by selected logic inputs
- Manual triggering by a remote control (TC10)
- Manual triggering by the SFT2841 software tool

Disturbance recording may be:

- Blocked by the SFT2841 software or by remote control (TC8)
- Validated by the SFT2841 software or by remote control (TC9)

Block Diagram



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Switching of Groups of Settings

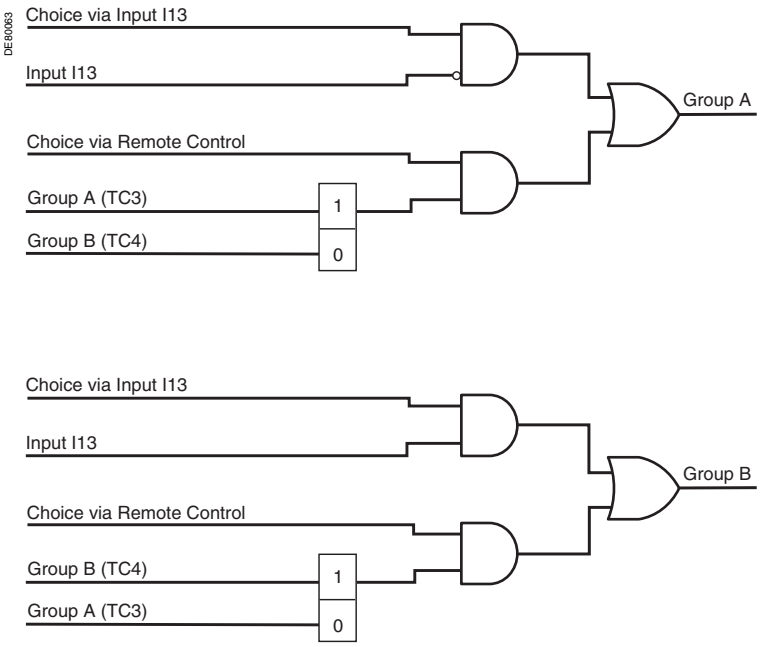
Description

There are four relays for the phase overcurrent and ground fault protection functions, split into two groups of two relays (Group A and Group B, respectively). The Sepam™ protective relays are used as specified in its parameter settings. The *Switching of Groups of Settings* function enables activation of the group A or group B protective functions:

- According to the status of logic input I13
  - I13 = 0: Activation of Group A
  - I13 = 1: Activation of Group B
- Or via the communication link
  - TC3: Activation of Group A
  - TC4: Activation of Group B.

The use of the switching of groups of settings functions does not exclude the use of the zone selective interlocking function.

Block Diagram



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Indications
ANSI Code 30

Events may be indicated on the front panel of Sepam™ relays by the:
- Appearance of a message on the advanced UMI display
- Lighting of one of the 9 yellow signal lamps

Message Type Indication

Predefined Messages

All the messages connected to the standard Sepam relay functions are predefined and available in two language versions:
- In English, factory messages, not editable
- In the local language, depending on the version delivered
  - The language version is chosen at the time of parameter setting
  - The messages are visible on the display units of Sepam relays equipped with the advanced UMI and in the SFT2841 Alarms screen
- The number and type of predefined messages depend on type of Sepam relay. The table below gives the complete list of all predefined messages.

List of Messages (1)

Functions	**UK English** (Factory)	**US English**
Phase Overcurrent	PHASE FAULT	PHASE FAULT
Ground Fault	EARTH FAULT	GROUND FAULT
Blocking Ground Fault Overcurrent	E/F PROT. BLOCK	50N/51N BLOCK
Circuit Breaker Failure	BREAKER FAILURE	BREAKER FAILURE
Thermal Overload	THERMAL ALARM	THERMAL ALARM
	THERMAL TRIP	THERMAL TRIP
Negative Sequence/Unbalance	UNBALANCE	UNBALANCE
Locked Rotor/	ROTOR BLOCKING	JAMMED/STALL
Locked Rotor on Start	ST^{RT} LOCKED ROT^{R}	LOCKED ROTOR
Excessive Starting Time	LONG START	LONG START
Starts per Hour	START BLOCK	BLOCKED START
Phase Undercurrent	UNDER CURRENT	UNDERCURRENT
Phase-to-Phase Overvoltage	OVERVOLTAGE	OVERVOLTAGE
Phase-to-Phase Undervoltage	UNDERVOLTAGE	UNDERVOLTAGE
Positive Sequence Undervoltage	UNDERVOLTAGE	UNDERVOLTAGE
Phase-to-Neutral Undervoltage	UNDERVOLT V1	UNDERVOLT Van
	UNDERVOLT V2	UNDERVOLT Vbn
	UNDERVOLT V3	UNDERVOLT Vcn
Neutral Voltage Displacement	Vo FAULT	Vr FAULT
Overfrequency	OVER FREQ.	OVER FREQ.
Underfrequency	UNDER FREQ.	UNDER FREQ.
Rate of Change of Frequency	ROCOF	df/dt
Temperature Monitoring (2)	OVER TEMP. ALM	OVER TEMP. ALM
	OVER TEMP. TRIP	OVER TEMP. TRIP
	RTD'S FAULT	RTD'S FAULT
Thermostat (3)	THERMOS^{T}. ALARM	THERMOS^{T}. ALARM
	THERMOS^{T}. TRIP	THERMOS^{T}. TRIP
Buchholz (3)	BUCHHOLZ ALARM	BUCHHOLZ ALARM
	BUCHH/GAS TRIP	BUCHH/GAS TRIP
Pressure (3)	PRESSURE TRIP	PRESSURE TRIP
Thermistor PTC/NTC	THERMIS^{T}. ALARM	THERMIS^{T}. ALARM
	THERMIS^{T}. TRIP	THERMIS^{T}. TRIP
Trip Circuit Supervision	TRIP CIRCUIT	TRIP CKT FAULT
Circuit Breaker/Contactor Control	CONTROL FAULT	CB CONTROL FAULT
Recloser	PERMANENT FAULT	PERMANENT FAULT
Recloser	CLEARED FAULT	CLEARED FAULT

(1) *Depending on the type of Sepam relay and whether equipped with advanced UMI, or SFT2841.*
Messages by default, the wording of the messages subject to change (please consult your local Schneider Electric sales representative for more information).
(2) *RTD fault message: refer to* Maintenance *on page 204.*
(3) *According to parameter setting of the logic inputs I21 to I24 (T20, T23 type).*

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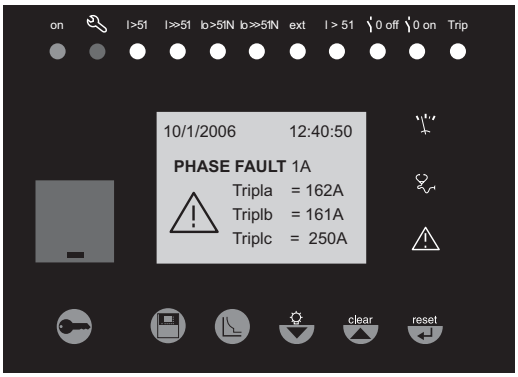

Alarm message on the advanced UMI

Message Processing on the Advanced UMI Display

When an event occurs, the related message appears on the advanced UMI display.

The user presses the clear key to clear the message and consult the advanced UMI screens normally.

The user must press the reset key to acknowledge latched events (e.g. protection outputs).

The list of messages remains accessible in the alarm history (key), in which the last 64 messages are stored.
To delete the messages stored in the alarm history:

- Display the alarm history on the advanced UMI
- Press the clear key

Signal Lamp Type Indication

The 9 yellow signal lamps on the front of Sepam™ are assigned by default to the following events:

Signal Lamp	Event	Label on Front Panel
LED 1	Tripping of Protection 50/51 Unit 1	I>51
LED 2	Tripping of Protection 50/51 Unit 2	I>>51
LED 3	Tripping of Protection 50N/51N Unit 1	Io>51N
LED 4	Tripping of Protection 50N/51N Unit 2	Io>>51N
LED 5		Ext
LED 6		
LED 7	Circuit Breaker Open (I11) (1)	0 off
LED 8	Circuit Breaker Closed (I12) (1)	I on
LED 9	Tripping by Circuit Breaker Control	Trip

(1) *Assignment by default with MES114.*

The default parameter setting may be personalized using the SFT2841 software:

- The assignment of signal lamps to events is to be defined in the control matrix screen
- Editing and printing of personalized labels are proposed in the *Sepam* menu

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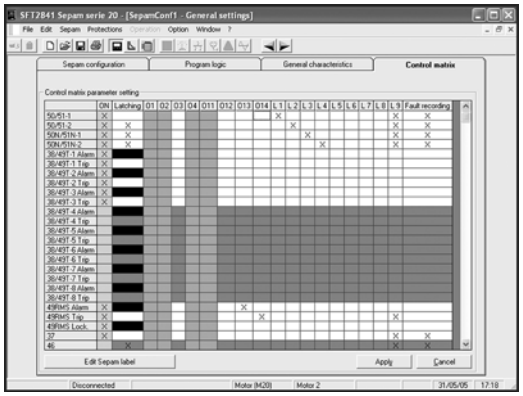
Control Matrix

PE50810



SFT2841: control matrix

The control matrix is used for simple assignment of the logic outputs and signal lamps to information produced by the protection units, program logic and logic inputs. Each column creates a logical OR between all the lines selected.

The following data are managed in the control matrix and may be set using the SFT2841 software tool.

Data	Meaning	Comments
All of the Application Protection Functions	Protection time-delayed output and additional outputs when applicable	
79 - Cleared Fault	The recloser function has sucessfully reclosed	Impulse type output
79 - Permanent Fault	The circuit breaker is definitively open after the reclosing shots	Impulse type output
Logic Inputs I11 to I14 and I21 to I26	According to configuration	If MES114 module is configured
BI Transmission	Sending of the blocking information to the following Sepam™ relay in zone selective interlocking chain	O3 by default
TCS	Trip circuit fault or mismatching of CB position contacts	If the circuit breaker / contactor control function is activated
CB Control Fault	A circuit breaker open or close command has not been executed	
Sensor Fault	Hardware problem on an MET module or on an RTD	
Pick-Up	Logical OR of the instantaneous output of all protection units	
Watchdog	Monitoring of Sepam operation	Always on O4 if used

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Access to Remote Settings	**106**
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Presentation

General

Sepam™ relays are connected to a Modbus communication network via a communication interface. This allows Sepam relays to be connected to a supervisor or any other device with a master Modbus communication channel.

Note: *Sepam relays are always a slave station.*

There are two communication interface types:

- Communication interfaces to connect Sepam relays to a single network
  - ACE9492, for connection to a 2-wire RS485 network
  - ACE959, for connection to a 4-wire RS485 network
  - ACE937, for connection to a fiber-optic star network

- Communication interfaces to connect Sepam relays to S-LAN or E-LAN networks
  - ACE969TP, for connection to:
    - One 2-wire RS485 Modbus S-LAN supervision communication network
    - One 2-wire RS485 E-LAN engineering communication network
  - ACE969FO, for connection to:
    - One fiber-optic Modbus S-LAN supervision communication network
    - One 2-wire RS485 E-LAN engineering communication network

Data Available

The data available depend on the type of Sepam relay.

Measurement Readout

- Phase and ground fault current
- Peak demand phase current
- Tripping current
- Cumulative breaking current
- Phase-to-phase, phase-to-neutral and residual voltage
- Frequency
- Temperature
- Thermal capacity used
- Starts per hour and block starting time
- Running hours counter
- Motor starting current and time
- Operating time before overload tripping
- Waiting time after tripping
- Operating time and number of operations
- Circuit breaker charging time

Program Logic Data Readout

- A table of 64 pre-assigned remote indications (TS) (depending on the type of Sepam relay) enables the readout of program logic data status
- Readout of the status of 10 logic inputs

Remote Control Commands

Writing of 16 impulse-type remote control commands (TC) in either direct mode or Select Before Operate (SBO) mode via 16 selection bits.

Other Functions

- Reading of Sepam relay configuration and identification
- Time-tagging of events (synchronization via the network or externally via logic input I21), time-tagging within a millisecond
- Remote reading of Sepam relay settings
- Remote setting of protection units
- Remote control of the analog output (with MSA141 option)
- Transfer of disturbance recording data

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Characterization of Exchanges

The Modbus protocol may be used to read or write one or more bits, one or more words, to the contents of the event counters or the contents of the diagnosis counters.

Modbus Functions Supported

The Modbus protocol used by Sepam™ is a compatible sub-group of the Modbus RTU protocol.
The functions listed below are handled by Sepam:

- Basic functions (data access):
  - Function 1: Reading of n output or internal bits
  - Function 2: Reading of n input bits
  - Function 3: Reading of n output or internal words
  - Function 4: Reading of n input words
  - Function 5: Writing of 1 bit
  - Function 6: Writing of 1 word
  - Function 7: High-speed reading of 8 bits
  - Function 8: Reading of diagnosis counters
  - Function 11: Reading of Modbus event counters
  - Function 15: Writing of n bits
  - Function 16: Writing of n words.
- Communication-management functions:
  - Function 8: Modbus diagnosis
  - Function 11: Reading of Modbus event counter
  - Function 43:
    - Sub-function 14: Reading of identification

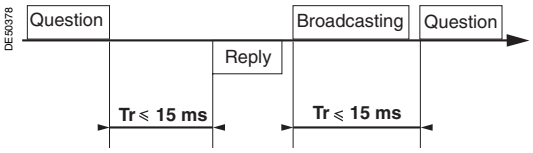
The following exception codes are supported:

- 1: Unknown function code
- 2: Incorrect address
- 3: Incorrect data
- 4: Not ready (cannot process request)
- 7: Not acknowledged (remote reading and setting)

Response Time

The communication coupler **response time (Tr)** is less than 15 ms, including a 3-character silence (approximately 3 ms at 9600 baud).
This time is given with the following parameters:

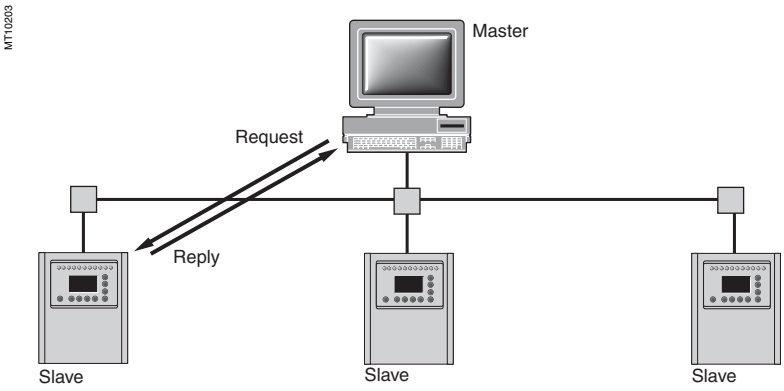
- 9600 baud
- Format: 8 bits, odd parity, 1 stop bit



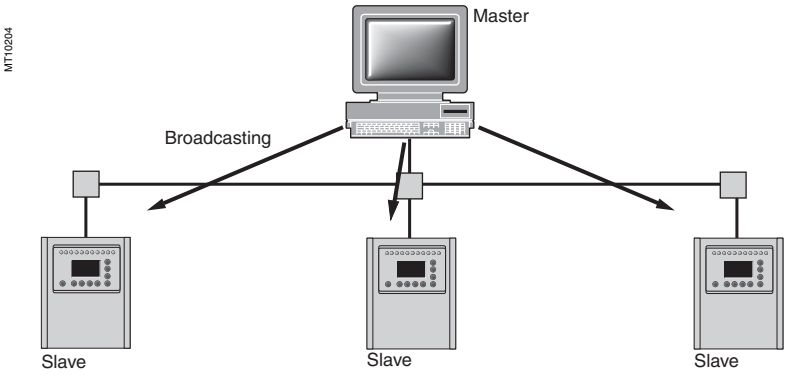
Synchronization of Exchanges

Any character that is received after a silence of more than 3 characters is considered as the beginning of a frame. A silence of at least 3 characters must be left on the line between two frames (e.g., at 9600 baud, this time is equal to approximately 3 ms).

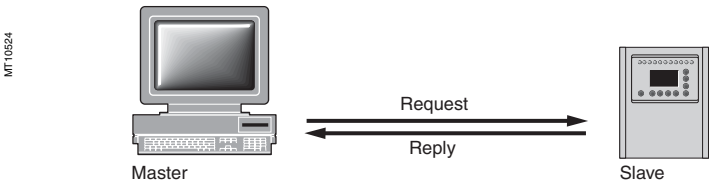
Protocol Principle



Exchanges are initiated by the master and include a request by the master and a reply by the slave (Sepam). Requests by the master are either addressed to a given Sepam relay identified by its number in the first byte of the request frame, or addressed to all the Sepam relays (broadcasting).



Broadcast commands are necessarily write commands. No replies are transmitted by the Sepam.



It is not necessary to have a detailed knowledge of the protocol unless the master is a central computer that requires the corresponding necessary programming. All Modbus exchanges include 2 messages: a request by the master and a reply by the Sepam.

All frames that are exchanged have the same structure, with each message or frame containing 4 types of data:

Slave	Function	Data	Cyclic Redundancy Check (CRC) 16
Number	Code	Zones	Check Zone

- Slave number (1 byte): this indicates the receiving Sepam (0 to FFh)
  If it is equal to zero, the request concerns all the slaves (broadcasting) and there is no reply message
- Function code (1 byte): this is used to select a command (read, write, bit, word) and to check that the reply is correct
- Data zones (n bytes): these zones contain the parameters relating to the function: bit, address, word address, bit value, word value, number of bits, number of words
- Check zone (2 bytes): this zone is used to detect transmission errors

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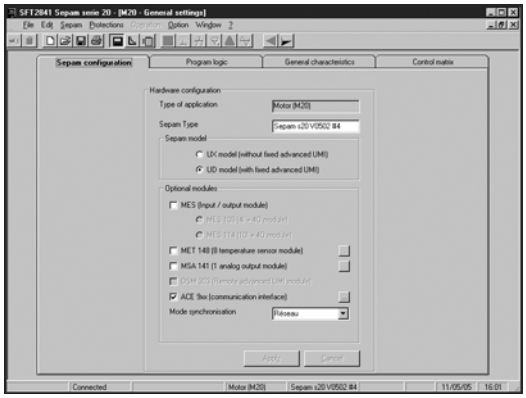
Configuring the Communication Interfaces

PE50583



SFT2841: Sepam Configuration Screen

Access to Configuration Parameters

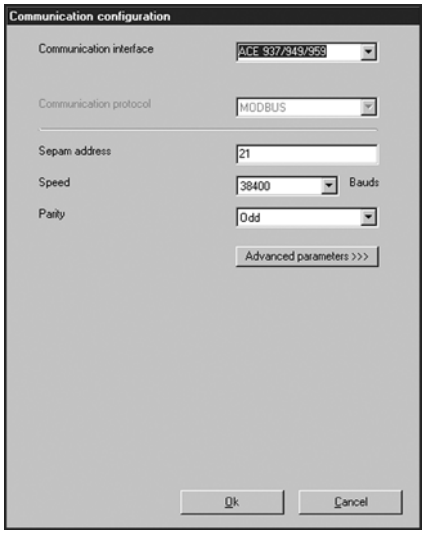
The Sepam™ communication interfaces are configured using the SFT2841 software. The configuration parameters can be accessed from the **Communication configuration** window in SFT2841. To access this window:

- Open the **Sepam configuration** window in SFT2841
- Check the box for ACE9xx (communication interface)
- Click [...]: the **Communication configuration** window appears
- Select the type of interface used: ACE949/ACE959/ACE937, ACE969TP or ACE969FO
- Select the Modbus communication protocol

The configuration parameters will vary depending on the communication interface selected: ACE949/ACE959/ACE937, ACE969TP or ACE969FO. The table below specifies the parameters to be configured depending on the communication interface chosen.

Parameters to Be Configured	ACE949 ACE959 ACE937	ACE969TP	ACE969FO
Physical Layer Parameters	■	■	■
Fiber-Optic Parameters			■
Modbus Advanced Parameters	■	■	■
E-LAN Parameters		■	■

PE50584



SFT2841: Communication Configuration Window for ACE949

Configuring the Physical Layer of the Modbus Port

Asynchronous serial transmission is used with the following character format:

- 8 data bits
- 1 stop bit
- Parity according to parameter setting.

The number of stop bits is always fixed at 1. If a configuration with Parity has been selected, each character will contain 11 bits (1 start bit + 8 data bits + 1parity bit + 1 stop bit). If a No Parity configuration has been selected, each character will contain 10 bits (1 start bit + 8 data bits + 1 stop bit).

The configuration parameters for the physical layer of the Modbus port are:

- Slave number (Sepam address)
- Transmission speed
- Parity check type

Parameters	Authorized values	Default value
Sepam™ Address	1–247	1
Speed	4800, 9600, 19200, or 38400 Baud	19200 Baud
Parity	None, Even, or Odd	Even

Configuring the ACE969FO Fiber-Optic Port

The configuration for the physical layer of the ACE969FO fiber-optic port is completed with the following 2 parameters:

- Link idle state: light-on or light-off
- Echo mode: with or without

Fiber-optic parameters	Authorized values	Default value
Link Idle State	Light Off or Light On	Light Off
Echo Mode	Yes (Fiber-Optic Ring) or No (Fiber-Optic Star)	No

Note: *In echo mode, the Modbus master will receive the echo of its own request before the slave's reply. The Modbus master must be able to disregard this echo. Otherwise, it is impossible to create a Modbus fiber-optic ring.*

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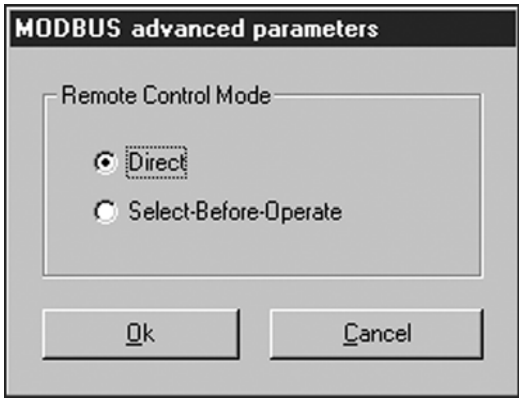
Configuring the Communication Interfaces



SFT2841: Modbus Advanced Parameters Window

Configuring Modbus Advanced Parameters

The Sepam™ relay remote control mode is selected from the *MODBUS Advanced Parameters* window.

Advanced Parameters	Authorized ValueS	Default Value
Remote Control Mode	Direct or Select Before Operate (SBO) Mode	Direct

Direct Remote Control Command

The remote control command is executed when it is written in the remote control word. The program logic resets it to zero after the remote control command is acknowledged.

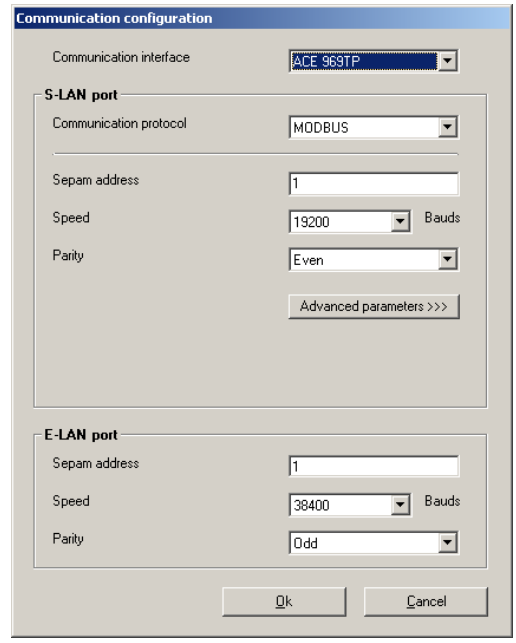
Confirmed Select Before Operate (SBO) Remote Control Command

In this mode, remote control command involve two steps:

- Selection by the master of the command to be sent by writing of the bit in the STC word and checking of the selection by rereading the word

  Note: *"STC" refers to a word in the Modbus communication section that describes remote control (TC=tele-control) commands through software.*

- Execution of the command to be sent by writing of the bit in the TC word



SFT2841: Communication Configuration Window for ACE969FO

Configuring the Physical Layer of the ACE969 E-LAN Port

The E-LAN port on the ACE969TP and ACE969FO communication interfaces is a 2-wire RS485 port.

The configuration parameters for the physical layer of the E-LAN port are:

- Sepam™ relay address
- Transmission speed
- Parity check type

The number of stop bits is always fixed at 1. If a configuration with Parity has been selected, each character will contain 11 bits (1 start bit + 8 data bits + 1parity bit + 1 stop bit). If a No Parity configuration has been selected, each character will contain 10 bits (1 start bit + 8 data bits + 1 stop bit).

Parameters	Authorized Values	Default Value
Sepam Address	1 to 247	1
Speed	4800, 9600, 19200 or 38400 Baud	38400 Baud
Parity	None, Even or Odd	Odd

Configuration Tips

- The Sepam relay's address MUST be assigned before it is connected to the communication network
- Set the other physical layer configuration parameters before making the connection to the communication network
- Modifying the configuration parameters during normal operation will not disturb Sepam but will reset the communication port

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Installing the Communication Network

Preliminary Study
Before installing any components, first perform a technical study to obtain the following information about the communication network:
- The type of medium (electrical or fiber optic)
- The number of Sepam™ units per network
- The transmission speed
- The ACE interfaces configuration
- The Sepam parameter settings

Sepam User Manual
Install and connect all communication interfaces in accordance with the instructions in the Installation chapter of this manual.

Preliminary Checks

Make the following preliminary checks:
- Check the CCA612 cord connection between the ACE interface and the Sepam base unit
- Check the ACE Modbus communication port connection
- Check the complete configuration of the ACE
- For the ACE969, check the auxiliary power supply connection

Checking the Operation of the ACE Interface

Use the following to establish that an ACE interface is operating correctly:
- The indicator LEDs on the front panel of the ACE
- The information provided by the SFT2841 software connected to Sepam:
  - On the **Diagnosis** screen
  - On the **Communication Configuration** screens

Link Activity LED for ACE9492, ACE959, and ACE937
The link activity LED for ACE9492, ACE959, and ACE937 interfaces flashes when Sepam transmission or reception is active.

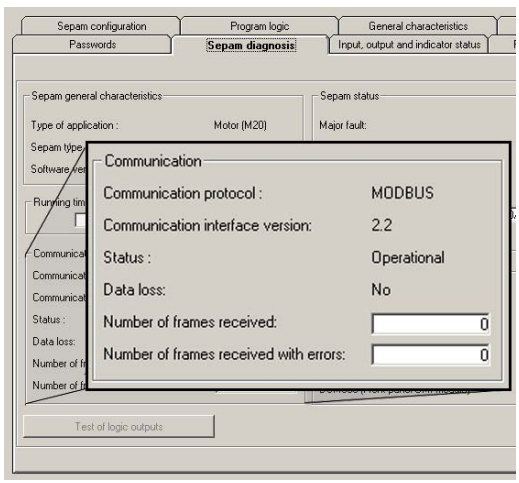
Indicator LEDs on the ACE969
- Green "on" LED: ACE969 energized
- Red "key" LED indicates ACE969 interface status
  - LED off: ACE969 configured and communication operational
  - LED flashing: ACE969 configuration error or ACE969 not configured
  - LED on: ACE969 error
- Link activity LED: S-LAN Tx flashing, Sepam transmission active
- Link activity LED: S-LAN Rx flashing, Sepam reception active

Diagnosis Using SFT2841 Software

Sepam Diagnosis Screen
When connected to Sepam, the SFT2841 software informs the operator of the general Sepam status and of the Sepam communication status in particular. All Sepam relay status information appears on the **Sepam diagnosis** screen.

Sepam Communication Diagnosis
The following information, provided by the SFT2841 software, can assist in identifying and resolving communication problems:
- Name of the protocol configured
- Modbus interface version number
- Number of valid frames received (CPT9)
- Number of invalid frames received (CPT2)

PE50687



SFT2841: Sepam Series 20 Diagnosis Screen

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Link Activity LED

The ACE interface link activity LEDs are activated by variations in the signal on the Modbus network. When the supervisor communicates with a Sepam™ relay (during transmission or reception), these LEDs flash. After wiring, check the information given by the link activity LEDs when the supervisor operates.

Note: *Flashing indicates that there is traffic passing to or from Sepam; it does not mean that the exchanges are valid.*

Functional Test

If there is any doubt about correct operation of the link:
- Run read/write shots in the test zone
- Use Modbus diagnosis function 8 (sub-code 0, echo mode).

The Modbus frames below, transmitted or received by a supervisor, are an example of a test performed when communications are set up.

Test Zone	
Read	
Transmission	01 03 0C00 0002 C75B
Reception	01 03 04 0000 0000 FA33
Write	
Transmission	01 10 0C00 0001 02 1234 6727
Reception	01 10 0C00 0001 0299
Read	
Transmission	01 03 0C00 0001 875A
Reception	01 03 02 1234 B533
Function 8 - Modbus Diagnosis, Echo Mode	
Transmission	01 08 0000 1234 ED7C
Reception	01 08 0000 1234 ED7C

Even in echo mode, the Sepam relay recalculates and checks the cyclic redundancy check (CRC) sent by the master:
- If the CRC received is valid, Sepam replies
- If the CRC received is invalid, Sepam does not reply

Modbus Diagnosis Counters

Counter Definition

Sepam manages the Modbus diagnosis counters. These are:
- **CPT1**: Number of valid frames received, whether the slave is involved or not
- **CPT2**: Number of frames received with a cyclic redundancy check (CRC) error or physical error (frames with more than 255 bytes, frames received with at least one parity, overrun, framing or line-break error)
- **CPT3**: Number of exception responses generated (even if not transmitted, due to receipt of a broadcast request)
- **CPT4**: Number of frames specifically addressed to the station (excluding broadcasting)
- **CPT5**: Number of valid broadcast frames received
- **CPT6**: Not significant
- **CPT7**: Not significant
- **CPT8**: Number of frames received with at least one character having a physical error (parity, overrun, framing or line break)
- **CPT9**: Number of valid requests received and correctly executed

Counter Reset

The counters are reset to 0:
- When they reach the maximum value FFFFh (65535)
- When they are reset by a Modbus command (function 8)
- When Sepam auxiliary power is lost
- When communication parameters are modified

Using the Counters

Modbus diagnosis counters help to detect and resolve communication problems. They can be accessed by the dedicated read functions (Modbus protocol functions 8 and 11).

CPT2 and CPT9 Counters Can Be Displayed on SFT2841

On the **Sepam Diagnosis** screen, an incorrect speed (or parity) increments CPT2 and non-reception is signaled by the lack of change on CPT9.

Operating Anomalies

To avoid confusing errors during commissioning, connect each Sepam unit to the Modbus network one at a time. Before connecting the next unit, confirm that the supervisor is sending frames to the relevant Sepam unit by checking the activity on the RS232–RS485 converter or the fiber-optic converter if there is one, and on the ACE module.

Additionally, depending on the network implementation, check the following items:

RS485 Network
- Wiring on each ACE module
- Tightness of the screw terminals on each ACE module
- Connection of the CCA612 cord linking the ACE module to the Sepam base unit
- Polarization is only at one point, with impedance matching at both ends of the RS485 network
- Auxiliary power supply connection to the ACE969TP
- ACE9092 or ACE919 converter used is connected, powered and set up correctly

Fiber-Optic Network
- Connections on the ACE module
- Connection of the CCA612 cord linking the ACE module to the Sepam base unit
- Auxiliary power supply connection to the ACE969FO
- Converter or fiber-optic star used is connected, powered and set up correctly
- For a fiber-optic ring, check that the Modbus master can handle the echo of its requests correctly

In All Cases
- All the ACE configuration parameters on SFT2841
- CPT2 and CPT9 diagnostic counters on the SFT2841 **Sepam Diagnosis** screen

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Presentation

Data which are similar from the monitoring and control application viewpoint are grouped together in adjacent address zones:

	Hexadecimal Starting Address	Ending Address	Modbus Functions Enabled
Synchronization Zone	0002	0005	3, 16
Identification Zone	0006	000F	3
First Event Table			
Exchange Word	0040	0040	3, 6, 16
Events (1 to 4)	0041	0060	3
Second Event Table			
Exchange Word	0070	0070	3, 6, 16
Events (1 to 4)	0071	0090	3
Data			
States	0100	0105	3, 4 1, 2*
Measurements	0106	0131	3, 4
Remote Control Commands	01F0	01F0	3, 4, 6, 16 1, 2, 5, 15*
Remote Control Confirmation	01F1	01F1	3, 4, 6, 16 1, 2, 5, 15*
Test Zone	0C00	0C0F	3, 4, 6, 16 1, 2, 5, 15
Protection Settings			
Reading	2000	207C	3
Reading Request	2080	2080	3, 6, 16
Remote Settings	2100	217C	3, 6
Disturbance Recording			
Choice of Transfer Function	2200	2203	3, 16
Identification Zone	2204	2228	3
Fault Rec. Exchange Word	2300	2300	3, 6, 16
Fault Rec. Data	2301	237C	3
Application			
Configuration	FC00	FC02	3
Application Identification	FC10	FC22	3

Note: *Non-addressable zones may reply by an exception message, or supply non-significant data.*

Note: *(*) These zones may be accessed in word mode or in bit mode.*

Note: *The address of bit i ($0 \leq i \leq F$) of address word J is then (J x 16) + i (e.g., 0C00 bit 0 = C000, 0C00 bit 7 = C007).*

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Synchronization Zone

The synchronization zone contains the absolute date and time for the time-tagging function. Time messages should be written in a single block containing 4 words, using function 16: write word. Messages can be read word by word or by groups of words using function 3.

Synchronization Zone	Word Address	Access	Modbus Function Enabled
Binary Time (Year)	0002	Read/Write	3/16
Binary Time (Months + Days)	0003	Read	3
Binary Time (Hours + Minutes)	0004	Read	3
Binary Time (ms)	0005	Read	3

See Time-Tagging of Events *for data format.*

Identification Zone

The identification zone contains system-type information pertaining to the identification of the Sepam™ equipment. Some of the information in the identification zone is also found in the configuration zone at the address FC00h.

Identification Zone	Word Address	Access	Modbus Function Enabled	Format	Value
Manufacturer Identification	0006	Read	3		0100
Equipment	0007	Read	3		0
Marking + Equipment Type	0008	Read	3		Idem FC01
Modbus Version	0009	Read	3		Idem FC02
Application Version	000A/B	Read	3	Not Managed	0
Sepam Check-Word	000C	Read	3		Idem 0100
Synthesis Zone	000D	Read	3	Not Managed	0
Command	000E	Read/Write	3/16	Not Managed	Init. to 0
Extension Address	000F	Read	3		FC00

This zone is provided to ensure compatibility with existing equipment. A more complete description is available starting at address FC00h in the configuration zone or using the identification read function.

First Events Zone

The events zone contains a maximum of 4 time-tagged events. Events should be read in a single block containing 33 words using function 3. The exchange word can be written using functions 6 or 16, and read individually using function 3.

Events Zone 1	Word Address	Access	Modbus Function Enabled
Exchange Word	0040	Read/Write	3/6/16
Event n°1	0041-0048	Read	3
Event n°2	0049-0050	Read	3
Event n°3	0051-0058	Read	3
Event n°4	0059-0060	Read	3

See Time-Tagging of Events *for data format.*

Second Events Zone

The events zone contains a maximum of 4 time-tagged events. Events should be read in a single block containing 33 words using function 3. The exchange word can be written using functions 6 or 16 and read individually using function 3.

Events Zone 2	Word Address	Access	Modbus Function Enabled
Exchange Word	0070	Read/Write	3/6/16
Event n°1	0071-0078	Read	3
Event n°2	0079-0080	Read	3
Event n°3	0081-0088	Read	3
Event n°4	0089-0090	Read	3

See Time-Tagging of Events *for data format.*

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Status Zone

The **status zone** is a table which contains the Sepam™ check-word, pre-assigned remote annunciation bits (TS), and logic inputs.

Status	Word Address	Bit Address	Access	Modbus Function Enabled	Format
Sepam Check-Word	100	1000	R	3/4 or 1, 2, 7	X
TS1-TS16	101	1010	R	3/4 or 1, 2	B
TS17-TS32	102	1020	R	3/4 or 1, 2	B
TS33-TS48	103	1030	R	3/4 or 1, 2	B
TS49-TS64	104	1040	R	3/4 or 1, 2	B
Logic Inputs	105	1050	R	3/4 or 1, 2	B

Measurement Zone (S20, S23, T20, T23 and M20 types)

Measurements	Word Address	Access	Modbus Function Enabled	Format	Unit
Ia Phase Current (Gain x 1)	106	Read	3/4	16NS	0.1 A
Ib Phase Current (Gain x 1)	107	Read	3/4	16NS	0.1 A
Ic Phase Current (Gain x 1)	108	Read	3/4	16NS	0.1 A
Ir Residual Current (Gain x 1)	109	Read	3/4	16NS	0.1 A
Ia Average Phase Current (x 1)	10A	Read	3/4	16NS	0.1 A
Ib Average Phase Current (x 1)	10B	Read	3/4	16NS	0.1 A
Ic Average Phase Current (x 1)	10C	Read	3/4	16NS	0.1 A
Ia Phase Current (Gain x 10)	10D	Read	3/4	16NS	1 A
Ib Phase Current (Gain x 10)	10E	Read	3/4	16NS	1 A
Ic Phase Current (Gain x 10)	10F	Read	3/4	16NS	1 A
Ir Residual Current (Gain x 10)	110F	Read	3/4	16NS	1 A
Ia Average Phase Current (x10)	111	Read	3/4	16NS	1 A
Ib Average Phase Current (x10)	112	Read	3/4	16NS	1 A
Ic Average Phase Current (x10)	113	Read	3/4	16NS	1 A
Ia Peak Demand Phase Current	114	Read	3/4	16NS	1 A
Ib Peak Demand Phase Current	115	Read	3/4	16NS	1 A
Ic Peak Demand Phase Current	116	Read	3/4	16NS	1 A
Reserved	117	Read	3/4	–	–
Trip Ia Tripping Current	118	Read	3/4	16NS	10 A
Trip Ib Tripping Current	119	Read	3/4	16NS	10 A
Trip Ic Tripping Current	11A	Read	3/4	16NS	10 A
Trip Ir Tripping Current	11B	Read	3/4	16NS	1 A
Cumulative Breaking Current	11C	Read	3/4	16NS	1 $(kA)^2$
Number of Operations	11D	Read	3/4	16NS	1
Operating Time	11E	Read	3/4	16NS	1 ms
Charging Time	11F	Read	3/4	16NS	1 s
Reserved	120	Read	3/4	–	–
Running Hours Counter	121	Read	3/4	16NS	1 hrs
Thermal Capacity Used	122	Read	3/4	16NS	%
Operating Time Before Overload Tripping	123	Read	3/4	16NS	1 min
Waiting Time After Overload Tripping	124	Read	3/4	16NS	1 min
Unbalance Ratio	125	Read	3/4	16NS	% I_B
Starting Time/Overload	126	Read	3/4	16NS	0.1 s
Starting Current Overload	127	Read	3/4	16NS	1 A
Block Start Time Delay	128	Read	3/4	16NS	1 min
Number of Starts Allowed	129	Read	3/4	16NS	1
Temperatures 1–8	12A/131	Read	3/4	16S	1° C
Reserved	132/1EF	Prohibited			

Note: *Only the measurements related to the Sepam function are significant. The values of the others are zero.*

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Measurement Zone (B20, B21, B22 types)

Measurements	Word Address	Access	Modbus Function Enabled	Format	Unit
Vab Phase to Phase Voltage (x1)	106	Read	3/4	16NS	1 V
Vbc Phase to Phase Voltage (x1)	107	Read	3/4	16NS	1 V
Vca Phase to Phase Voltage (x1)	108	Read	3/4	16NS	1 V
Van Phase to Neutral Voltage (x1)	109	Read	3/4	16NS	1 V
Vbn Phase to Neutral Voltage (x1)	10A	Read	3/4	16NS	1 V
Vcn Phase to Neutral Voltage (x1)	10B	Read	3/4	16NS	1 V
Vr Residual Voltage (x1)	10C	Read	3/4	16NS	1 V
V1 Positive Sequence Voltage (x1)	10D	Read	3/4	16NS	1 V
Frequency	10E	Read	3/4	16NS	0.01 Hz
Vab Phase to Phase Voltage (x10)	10F	Read	3/4	16NS	1 V
Vbc Phase to Phase Voltage (x10)	110	Read	3/4	16NS	1 V
Vca Phase to Phase Voltage (x10)	111	Read	3/4	16NS	1 V
Van Phase to Neutral Voltage (x10)	112	Read	3/4	16NS	1 V
Vbn Phase to Neutral Voltage (x10)	113	Read	3/4	16NS	1 V
Vcn Phase to Neutral Voltage (x10)	114	Read	3/4	16NS	1 V
Vr Residual Voltage (x10)	115	Read	3/4	16NS	1 V
V1 Positive Sequence Voltage (x10)	116	Read	3/4	16NS	1 V
Reserved	*117/131*	*Read*	*3/4*		*init. to 0*
Reserved	*132/1EF*	*Prohibited*			

Accuracy

The accuracy of the measurements depends on the order of the unit: it is equal to the value of the point divided by 2.

Examples		
I1	Unit = 1 A	Accuracy = 1/2 = 0.5 A
U21	Unit = 10 V	Accuracy = 10/2 = 5 V

Remote Control Zone

The **remote control zone** contains the pre-assigned remote control bits (TC). The zone may be read or written using the word functions or bit functions (see section on remote control commands).

Remote Control Bits	Word Address	Bit Address	Access	Modbus Function Enabled	Format
TC1-TC16	01F0	1F00	Read/Write	3/4/6/16 1/2/5/15	B
STC1-STC16	01F1	1F10	Read/Write	3/4/6/16 1/2/5/15	B
Analog Output Control	01F2		Read/Write	3/4/6/16	16S

Protection Setting Zone

The **protection setting zone** is an exchange table which is used to read and set protections.

Protection Settings	Word Address	Access	Modbus Function Enabled	
Setting Read Buffer	2000/207C	Read	3	
Setting Read Request	2080	Read/Write	3/6/16	–
Remote Setting Request Buffer	2100/217C	Read/Write	3/16	

See Protection Settings *section.*

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Fault Recorder Zone

The fault recorder zone is an exchange table which is used to read records.

Disturbance Recording	Word Address	Access	Modbus Function Enabled
Choice of Transfer Function	2200/2203	Read/Write	3/16
Identification Zone	2204/2228	Read	3
Fault Rec. Exchange Word	2300	Read/Write	3/6/16
Fault Rec. Data	2301/237C	Read	3

See Fault Recorder *section.*

Test Zone

The test zone is a 16-word zone that may be accessed via the communication link by all the functions, in both read and write modes, to facilitate communication testing at the time of commissioning or to test the link.

Test Zone	Word Address	Bit Address	Access	Modbus Function Enabled	Format	
Test	0C00	C000-C00F	Read/Write	1/2/3/4/5/6/15/16	none	init. to 0
	0C0F	C0F0-C0FF	Read/Write	1/2/3/4/5/6/15/16	none	init. to 0

Configuration Zone

The configuration zone contains information pertaining to the hardware and software configuration of the Sepam™.

Configuration Zone	Word Address	Access	Modbus Function Enabled	Format	
Modbus Address (Slave no.)	FC00	Read	3		
Sepam Type (MSB) / Hardware Configuration (LSB)	FC01	Read	3	(1)	
Coupler Type (MSB)/ Version (LSB)	FC02	Read	3	(2)	
Application Identification					
Type of Application (S20, M20, etc.)	FC10/15	Read	3	ASCII	12 Characters
Application Version	FC16/18	Read	3	ASCII	6 Characters
Application Marking	FC19/22	Read	3	ASCII	20 Characters

(1) *FC01 word:MSB = 10h (Sepam)*
LSB = hardware configuration

(2) *FC02 word:MSB = 01h (Sepam)*
LSB = XY (communicationversion X,Y)

Bit Option	7 UD/UX	6 reserved	5 MES114E/ MES114F	4 DSM303	3 MSA141	2 MET1482 (3)	1 MES114	0 MES108
UX Model	0	0	z	x	x	x	y	y
UX Model	1	0	z	0	x	x	y	y

(3) *or MET148.*
x = 1 if option included
y = 1 if option included, exlusive options
z = 1 if Vac set up

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Data Encoding

For All Formats
If a measurement overruns the maximum permissible value for the related format, the value read for the measurement will be the maximum permissible value for the format.

Format 16 NS
All information is encoded in a 16-bit word, in absolute value (unsigned), binary format. The zero bit (b0) is the least significant bit in the word.

Format 16 S Signed Measurements (Temperatures, …)
The information is encoded in a 16-bit word as a complement of 2, for example:
- 0001 represents +1
- FFFF represents -1

Format B: Ix
Rank i bit in the word, with i between 0 and F.

Examples		F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
Logic Inputs	Word Address 0105							26	25	24	23	22	21	14	13	12	11
	Bit Address 105x																
TS1 to TS16	Word Address 0101	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Bit Address 101x																
TS49 to TS64	Word Address 0104	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
	Bit Address 104x																
TC1 to TC16	Word Address 01F0	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Bit Address 1F0x																
STC1 to STC16	Word Address 01F1	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Bit Address 1F1x																

Format X: Sepam™ Check-Word
This format applies only to the Sepam™ check-word that may be accessed at the word address 100h. This word contains various items of information relating to:
- Sepam operating mode
- Time-tagging of events

Each data item contained in the Sepam check-word may be accessed bit by bit, from address **1000** for the bit b0 to **100F** for the bit b15.
- Bit 15: Event present
- Bit 14: Sepam in “data loss” status
- Bit 13: Sepam not synchronous
- Bit 12: Sepam time not correct
- Bit 11: Reserved
- Bit 10: Sepam in local setting mode
- Bit 9: Major fault in Sepam
- Bit 8: Partial fault in Sepam
- Bit 7: Setting group A in service
- Bit 6: Setting group B in service
- Bit 3-0: Mapping number (1 to 16)

Other bits reserved (undetermined values).

Status changes of bits 6, 7, 8, 10, 12, 13 and 14 of this word trigger the transmission of a time-tagged event. Bits 3 to 0 encode a “mapping number” (1–15) which is used to identify the contents of the Modbus addresses, the assignment of which varies depending on the application.

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Use of Remote Annunciation

Sepam™ provides the communication link with 64 remote annunciation bits (TS); pre-assigned to protection and control functions, dependent on the Sepam model. The TS can be read using the bit or word functions. Each TS transition is time-tagged and stored in the event stack (see section Time-tagging of events).

Address Word 0101: TS1 to TS16 (Bit Address 1010 to 101F)

TS	Use	S20	S23	T20	T23	M20	B21	B22
1	Protection 50/51 Relay 1 Group A	■	■	■	■	■		
2	Protection 50/51 Relay 2 Group A	■	■	■	■	■		
3	Protection 50/51 Relay 1 Group B	■	■	■	■	■		
4	Protection 50/51 Relay 2 Group B	■	■	■	■	■		
5	Protection 50N/51N Relay 1 Group A	■	■	■	■	■		
6	Protection 50N/51N Relay 2 Group A	■	■	■	■	■		
7	Protection 50N/51N Relay 1 Group B	■	■	■	■	■		
8	Protection 50N/51N Relay 2 Group B	■	■	■	■	■		
9	Protection 49 RMS Alarm Set Point			■	■	■		
10	Protection 49 RMS Tripping Set Point			■	■	■		
11	Protection 37					■		
12	Protection 46	■	■	■	■	■		
13	Protection 48/51LR/14 (Locked Rotor)					■		
14	Protection 48/51LR/14 (Locked Rotor on Start)					■		
15	Protection 48/51LR/14 (Excessive Starting Time)					■		
16	Protection 66					■		

Address Word 0102: TS17 to TS32 (Bit Address 1020 to 102F)

TS	Use	S20	S23	T20	T23	M20	B21	B22
17	Protection 27D/47 Relay 1						■	■
18	Protection 27D/47 Relay 2						■	■
19	Protection 27 Relay 1						■	■
20	Protection 27 Relay 2						■	■
21	Protection 27R						■	■
22	Protection 59 Relay 1						■	■
23	Protection 59 Relay 2						■	■
24	Protection 59N Relay 1						■	■
25	Protection 59N Relay 2						■	■
26	Protection 81H						■	■
27	Protection 81L Relay 1						■	■
28	Protection 81L Relay 2						■	■
29	Protection 27S Phase 1						■	■
30	Protection 27S Phase 2						■	■
31	Protection 27S Phase 3						■	■
32	Protection 81R							■

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Address Word 0103: TS33 to TS48 (Bit Address 1030 to 103F)

TS	Use	S20	S23	T20	T23	M20	B21	B22
33	Protection 50BF		■		■			
34	Recloser in Service	■	■					
35	Recloser in Progress	■	■					
36	Recloser Permanent Trip	■	■					
37	Recloser Successful Trip	■	■					
38	Send Blocking Input	■	■	■	■	■		
39	Remote Setting Blocked	■	■	■	■	■	■	■
40	Remote Control Blocked	■	■	■	■	■	■	■
41	Sepam™ Not Reset After Fault	■	■	■	■	■	■	■
42	Remote Control/Position Discrepancy	■	■	■	■	■	■	■
43	Matching Fault or Trip Circuit Supervision	■	■	■	■	■	■	■
44	Disturbance Recording Memorized	■	■	■	■	■	■	■
45	Control Fault	■	■	■	■	■	■	■
46	Disturbance Recording Blocked	■	■	■	■	■	■	■
47	Thermal Protection Blocked			■	■	■		
48	RTD Fault			■	■	■		

Address Word 0104: TS49 to TS64 (Bit Address 1040 to 104F)

TS	Use	S20	S23	T20	T23	M20	B21	B22
49	Protection 38/49T Alarm Set Point Sensor 1			■	■	■		
50	Protection 38/49T Tripping Set Point Sensor 1			■	■	■		
51	Protection 38/49T Alarm Set Point Sensor 2			■	■	■		
52	Protection 38/49T Tripping Set Point Sensor 2			■	■	■		
53	Protection 38/49T Alarm Set Point Sensor 3			■	■	■		
54	Protection 38/49T Tripping Set Point Sensor 3			■	■	■		
55	Protection 38/49T Alarm Set Point Sensor 4			■	■	■		
56	Protection 38/49T Tripping Set Point Sensor 4			■	■	■		
57	Protection 38/49T Alarm Set Point Sensor 5			■	■	■		
58	Protection 38/49T Tripping Set Point Sensor 5			■	■	■		
59	Protection 38/49T Alarm Set Point Sensor 6			■	■	■		
60	Protection 38/49T Tripping Set Point Sensor 6			■	■	■		
61	Protection 38/49T Alarm Set Point Sensor 7			■	■	■		
62	Protection 38/49T Tripping Set Point Sensor 7			■	■	■		
63	Protection 38/49T Alarm Set Point Sensor 8			■	■	■		
64	Protection 38/49T Tripping Set Point Sensor 8			■	■	■		

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Use of Remote Control Commands

Remote control commands are pre-assigned to protection, control and metering functions.
Remote control commands may be carried out in two modes:

- Direct mode
- Confirmed SBO (select before operate) mode.

All the remote control commands can be blocked by logic input I25 on the MES114 module.

According to the parameter setting of logic input I25, the tripping remote control TC1 can be activated at any time or can be blocked.
Logic input I25 can be set up according to 2 modes:

- Blocked if the input is set to 1 ("POS" prefix)
- Blocked if the input is set to 0 ("NEG" prefix)

The device tripping and closing and recloser enable and disable remote control are acknowledged if the “CB control“ function is validated and if the inputs necessary for the logic are present on the MES114 (or MES108) optional module.

Direct Remote Control Commands

The remote control is executed when it is written in the remote control word. The program logic resets it to zero after the remote control is acknowledged.

Confirmed Select Before Operate (SBO) Remote Control Commands

In this mode, remote control commands involve two steps:

- Selection, by the master, to be sent by writing of the bit in the STC word and checking of the selection by rereading the word
- Execution of the command to be sent by writing of the bit in the TC word

The remote control is executed if the bit in the STC word and the bit in the associated word are set; the program logic resets the STC and TC bits to zero after the remote control is acknowledged.

Deselection of the STC bit takes place:

- If the master deselects it by writing in the STC word
- If the master selects (write bit) a bit other than the one already selected
- If the master sets a bit in the TC word which does not match the selection. In this case, no remote control command is executed

Address Word 01F0: TC1 to TC16 (Bit Address 1F00 to 1F0F)

TC	Use	S20	S23	T20	T23	M20	B21	B22
1	Tripping	■	■	■	■	■	■	■
2	Closing	■	■	■	■	■	■	■
3	Switching to Setting Group A	■	■	■	■	■		
4	Switching to Setting Group B	■	■	■	■	■		
5	Sepam™ Reset	■	■	■	■	■	■	■
6	Peak Demand Current Zero Reset	■	■	■	■	■		
7	Block Thermal Protection			■	■	■		
8	Block Disturbance Recording Triggering	■	■	■	■	■	■	■
9	Confirm Disturbance Recording Triggering	■	■	■	■	■	■	■
10	Manual Disturbance Recording Triggering	■	■	■	■	■	■	■
11	Enable Recloser	■	■					
12	Disable Recloser	■	■					
13	Confirm Thermal Protection			■	■	■		
14	Reserved							
15	Reserved							
16	Reserved							

Analog Output Remote Control

The analog output of the MSA141 module may be set up for remote control via the Modbus communication module (word address 01F2). The working range of the numerical value transmitted is defined by the parameter setting of the "min. value" and "max. value" of the analog output. This function is not affected by remote control blocking conditions.

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Time-Tagging of Events

Presentation

The communication system time-tags the data prcessed by Sepam™. The time-tagging function assigns a date and precise time to status changes so that they can be accurately classified over time. Time-tagged data are events that can be processed in the control room by the remote monitoring and control system using the communication protocol for data logging and chronological reports.

Sepam time-tags the following data:
- Logic inputs
- Remote annunciation bits
- Information pertaining to Sepam equipment (see Sepam check-word)

Time-tagging is carried out systematically. Chronological sorting of the time-tagged events is performed by the remote monitoring and control system.

Time-Tagging
Sepam time-tagging uses absolute time (see section on date and time). When an event is detected, it is tagged with the absolute time given by Sepam's internal clock.

All the Sepam internal clocks must be synchronized so as to avoid drifts and all be the same to allow inter-Sepam chronological sorting. Sepam has two mechanisms for managing its internal clock:

- **Time-Setting:**

For initializing or modifying the absolute time. A special Modbus message, called "time message", is used to time-set each Sepam

- **Synchronization:**

To avoid Sepam internal clock drifts and ensure inter-Sepam synchronization. Internal clocks can be synchronized according to two principles:
  - Internal Synchronization:
    Via the communication network without any additional cabling
  - External Synchronization:
    Via a logic input with additional cabling. At the time of commissioning, the user sets the synchronization mode parameter

Initialization of the Time-Tagging Function
Each time the communication system is initialized (Sepam is energized), events are generated in the following command:
- Appearance of "data loss"
- Appearance of "incorrect time"
- Appearance of "not synchronous"
- Disappearance of "data loss"

The function is initialized with the current values of the remote annunciation and logic input status. After the initialization phase, event detection is activated. It can only be interrupted by saturation of the internal event storage queue or by the presence of a major fault in Sepam.

Date and Time

An absolute date and time are generated internally by Sepam, in the following standard format (IEC870-5-4): Year: Month: Day: Hour: minute: millisecond.

The internal clock is not saved and must be set via the communication network each time the Sepam relay is energized. This can be accomplished two ways:
- By the remote monitoring and control system, via the Modbus link
- Via the SFT2841 software, on the **General Characteristics** screen

The time that is tagged on events is encoded in 8 bytes as follows:

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00	Word
0	0	0	0	0	0	0	0	0	Y	Y	Y	Y	Y	Y	Y	Word 1
0	0	0	0	M	M	M	M	0	0	0	D	D	D	D	D	Word 2
0	0	0	H	H	H	H	H	0	0	mn	mn	mn	mn	mn	mn	Word 3
ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	Word 4

- **Y** — Years
  - 1 byte
  - Value from 0–99
  - The monitoring/control system must ensure the value 00 is greater than 99
- **M** — Months
  - 1 byte
  - Value from 1–12
- **D** — Days
  - 1 byte
  - Value from 1–31
- **H** — Hours
  - 1 byte
  - Value from 0 to 23
- **mn** — Minutes
  - 1 byte
  - Value from 0–59
- **ms** — Milliseconds
  - 2 byte
  - Value from 0–59999

This information is encoded in binary form. Sepam is time-set via the "write word" function (function 16) at the address 0002 with a mandatory 4-word time message. The bits set to "0" in the description above correspond to format fields which are not used and not generated by Sepam. Since these bits can be transmitted to Sepam with random values, Sepam performs the necessary disabling, but does not check the consistency or validity of the date and time received.

Synchronization Clock

A synchronization clock is required for setting the date and time of Sepam. Schneider Electric has tested the following equipment:
- Gorgy Timing, Ref. RT 300, Equipped with the M540 Module
- Cyber Sciences Module, STR-100

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Reading of Events

Sepam™ provides the master or masters with two event tables. The master reads the event table and acknowledges by writing the exchange word, while Sepam updates its event table.

Event Table Structure

Structure of the first event table:
- Exchange word 0040h
- Event number 1
  0041h ... 0048h
- Event number 2
  0049h ... 0050h
- Event number 3
  0051h ... 0058h
- Event number 4
  0059h ... 0060h

Structure of the second event table:
- Exchange word 0070h
- Event number 1
  0071h ... 0078h
- Event number 2
  0079h ... 0080h
- Event number 3
  0081h ... 0088h
- Event number 4
  0089h ... 0090h

Note: *The events sent by Sepam relays are not sorted chronologically.*

Note: *The master necessarily reads a block of 33 words starting at the address 0040h/0070h, or one word at the address 0040h/0070h.*

Exchange Word
The exchange word is used to manage a special protocol to prevent loss of events following a communication problem. The event table is numbered for this purpose.

The exchange word includes two fields:
- Most significant byte = exchange number (8 bits): 0..255

b15	b14	b13	b12	b11	b10	b09	b08

Exchange Number: 0 .. 255

Description of the MS Byte of the Exchange Word

The exchange number includes a byte that identifies the exchanges. This byte is initialized to zero when Sepam is energized. When it reaches its maximum value (FFh), it automatically returns to 0. Sepam numbers the exchanges and the master acknowledges the numbering.

- Least significant byte = number of events (8 bits): 0..4

b07	b06	b05	b04	b03	b02	b01	b00

Number of Events: 0 .. 4

Description of LS Byte of the Exchange Word

Sepam indicates the number of significant events in the event table in the least significant byte of the exchange word. Each non-significant event word is initialized to zero.

Event Table Acknowledgment
To inform Sepam that the block read by the master has been correctly received, the master writes the number of the last exchange made in the **Exchange number** field, and resets the **Number of events** field of the exchange word to zero. After acknowledgment, the 4 events in the event table are initialized to zero and the old, acknowledged events are erased in Sepam.

Until the exchange word written by the master becomes “X,0” (where X = number of the previous exchange that the master wishes to acknowledge), the exchange word in the table remains at “X, number of previous events”. The Sepam relay only increments the exchange number when new events are present (X+1, number of new events).

If the event table is empty, Sepam performs no processing operations when the master reads the event table or the exchange word. This data is binary encoded.

Clearing an Event Queue
Writing a value "xxFFh" in the exchange word (any exchange number, event number = FFh) reinitializes the corresponding event queue (all stored events not yet transmitted are deleted).

Sepam in Data Loss (1)/No Data Loss (0) Status
Sepam has an internal storage queue with a capacity of 64 events. If the queue becomes saturated, a "data loss" event is inserted by Sepam when each event table is read. The detection of events stops and the most recent events are lost.

Data loss is managed independently for each of the two event tables. When the tables are read at different rates, data loss may occur at different times for each table or even, in some cases, appear only on the slowest channel.

Note: *The "data loss" bit of the Sepam check word corresponds to the status of the first reading table (compatibility with earlier versions).*

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Description of Event Encoding

An event is encoded in 8 words with the following structure:

Most Significant Byte	Least Significant Byte	
Word 1: Type of Event		
08	00	For Remote Annunciation, Internal Data, Logic Inputs
Word 2: Event Address		
		Refer to Bit Addresses 1000 to 105F
Word 3: Reserved		
00	00	
Word 4: Falling Edge: Disappearance or Rising Edge: Appearance		
00	00	Falling Edge
00	01	Rising Edge
Word 5: Year		
00	0–99 (Year)	
Word 6: Month-Day		
1–12 (Month)	1–31 (Day)	
Word 7: Hours-Minutes		
0–23 (Hours)	0–59 (Minutes)	
Word 8: Milliseconds		
0–59999		

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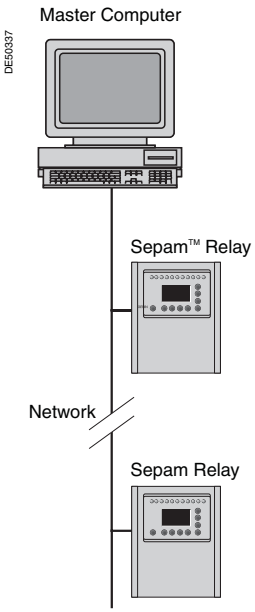
Time-Tagging of Events



Architecture for "Internal Synchronization" via the Communication Network

Synchronization

Sepam™ accommodates two synchronization modes:

- Internal via the Network
  Synchronization mode by the broadcasting of a "time message" frame via the communication network, slave number 0 is used for broadcasting
- External
  Synchronization mode via a logic input (selected at commissioning via SFT2841)

Internal Synchronization via the Network Mode

The “time message" frame is used for both time-setting and synchronization of Sepam. In this case, it must be sent regularly at brief intervals (between 10–60 s) in order for synchronous time to be obtained.

The Sepam relay’s internal clock is reset each time a new time frame is received, and synchronization is maintained if the difference in synchronism is less than 100 milliseconds.

With internal synchronization via the network, accuracy is linked to the master and its mastery of time frame transmission in the communication network. The Sepam relay is synchronized without delay at the end of the receipt of the frame.

The time is changed by sending a frame to Sepam with the new date and time. Then, Sepam switches to a transitional, non-synchronous status. When in synchronous status, if no "time message” is received for 200 seconds, the appearance of the “not synchronous” event is triggered.

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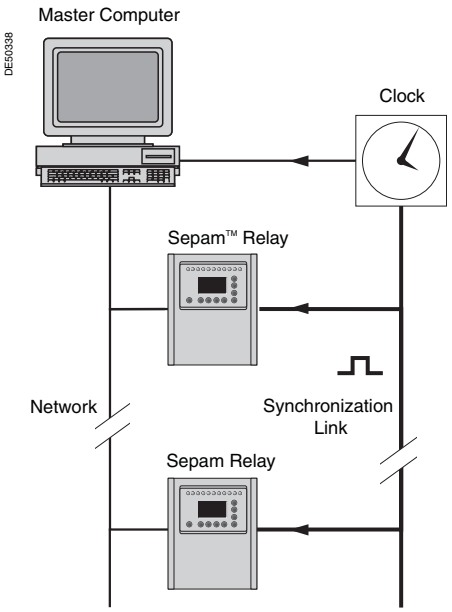

Architecture for "External Synchronization" via a Logic Input

Synchronization (cont'd)

External synchronization via a logic input mode

The Sepam™ relay can be synchronized externally by means of a logic input (I21) — the MES114 module is required. The synchronisation pulse is determined by the rising edge of the logic input.

Sepam can adapt to all synchronization pulse periods from 10–60 s, in 10 s increments. The shorter the synchronization period, the more accurately status changes are time-tagged.

The first time frame is used to initialize Sepam with the absolute date and time (the following frames are used for the detection of any time changes). The synchronization pulse is used to reset the Sepam relay's internal clock. In the initialization phase, when Sepam is in "non-synchronous" mode, resetting is allowed within an amplitude of ±4 seconds.

In the initialization phase, the resetting process (switching of Sepam into "synchronous" mode) is based on a measurement of the difference between the relay's current time and the nearest ten second period. This measurement is taken at the time of the receipt of the synchronization pulse following the initialization time frame. Resetting is allowed if the difference is less than or equal to 4 seconds, in which case Sepam switches to "synchronous" mode.

Upon switching to "synchronous" mode, the resetting process is based on the measurement of the difference between the relay's current time and the nearest ten second period at the time of the receipt of a synchronization pulse (adapted to match the synchronization pulse period).

The synchronization pulse period is determined automatically by Sepam when it is energized, based on the first two pulses received. Therefore, the synchronization pulse must be operational before Sepam is energized.

The synchronization function only operates after Sepam has been time-set, i.e. after the disappearance of the "incorrect time" event.

Any time changes greater than ±4 seconds in amplitude are made by sending a new time frame. The switch from daylight savings time to standard time (and vice versa) is made in this way as well.

There is a temporary loss of synchronism when the time is changed. The external synchronization mode requires additional equipment: a "synchronization clock " to generate a precise periodic synchronization time pulse.

If Sepam is in "correct time and synchronous" status, and if the difference in synchronism between the nearest ten second period and the receipt of the synchronization pulse is greater than the synchronism error for 2 consecutive synchronization pulses, it switches into non-synchronous status and generates the appearance of a "not synchronous" event.

Likewise, if Sepam is in "correct time and synchronous" status, the failure to receive a synchronization pulse for 200 seconds generates the appearance of a "not synchronous" event.

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Reading of Remote Settings (Remote Reading)

Settings Accessible For Remote Reading
Reading of the settings of all the protection functions may be accessed remotely.

Exchange Principle
Remote reading of settings takes place in two steps:
- The master indicates the code of the function for which it wishes to know the settings by means of a "request frame" — the request is acknowledged, in the Modbus sense of the term, to free the network
- The master then reads a reply zone to find the required information by means of a "reply frame"

Each function has its own particular reply zone contents. The time needed between the request and the reply is linked to the Sepam relay's low priority shot time and may vary by several tens to several hundreds of milliseconds.

Request Frame
The request is made by the master using a "write word" (function 6 or 16) operation at the address 2080h of a 1-word frame consisting of the following:

2080h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function Code								Relay Number							

The content of the address 2080h may be read using a Modbus "read word" (function 3). The function code field may have the following values:
- 01h to 99h (BCD encoding) for protection functions.

The relay number field is used as follows:
- For protection, it indicates the relay involved, varying from 1 to N, N being the maximum number of relays available in the Sepam™
- When only one relay is available, this number field is not controlled

Exception Replies
In addition to the usual cases, Sepam™ can send Modbus (type 07) exception replies (not acknowledged) if another remote reading request is being processed.

Reply Frame
The reply, sent back by the Sepam, fits into a zone containing a maximum of 125 words at the address 2000h which is composed the following:

2000h/207Ch

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function Code								Relay Number							
Settings															
.....															
(Special Field for Each Function)															
.....															

This zone is read by a "read word" operation (function 3) at the address 2000h. The length of the exchange may include:
- The first word only (validity test)
- The maximum size of the zone (125 mots)
- The usable size of the zone (determined by the function being addressed)

However, reading must always begin at the first word in the zone (any other address triggers an exception reply "incorrect address"). The first word in the zone (function code and relay number) may have the following values:
- **xxyy**
  - Function code xx different from 00 and FFh
  - Relay number yy different from FFh.
    - The settings are available and validated
    - The word is a copy of the "request frame"
    - The zone contents remain valid until the next request is made
    - The other word are not significant
- **FFFFh**
  - The "request frame" has been processed, but the results in the "reply frame" are not yet available
  - It is necessary to repeat "reply frame" reading
  - The other words are not significant
- **xxFFh**
  - With function code xx different from 00 and FFh
  - The function for which the remote reading request has been made is not valid
  - The function is not included in the particular Sepam, or remote reading of it is not authorized: refer to the list of functions which accommodate remote reading of settings

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⚠ CAUTION

RISK OF UNINTENDED OPERATION

- The device must only be configured and set by qualified personnel, using the results of the installation protection system study.
- During commissioning of the installation and following any modification, check that the Sepam™ relay configuration and protection function settings are consistent with the results of this study.

Failure to follow these instructions may result in equipment damage.

Remote Setting

Data That Can be Remotely Set

Writing of the settings of all the protection functions may be accessed remotely.

Exchange Principle

Remote setting is allowed for Sepam units, and is carried out for a given function relay-by-relay. The remote setting takes place in two steps:

- The master indicates the function code and relay number, followed by the values of all the settings in the a "write request frame" (the request is acknowledged to free the network)
- Then, the master reads a reply zone to find the required information by means of a "reply frame", a reply zone designed for checking that the settings have been processed
  - Each function has its own particular reply zone contents
  - The contents are same as those of the reply frame

It is necessary to make all the settings for the function concerned, to use remote setting, even if some of the settings have not changed.

Request Frame

The request is made by the master using a "write n words" (function 16) operation at the address 2100h. The zone to be written contains a maximum of 125 words, the values of all the settings, and it consists of the following:

2100h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function Code								Relay Number							
Settings															
.....															
(Special Field for Each Function)															
.....															

The content of the address 2100h may be read using a "read n words" (function 3). The function code field may have the following values:

- 01h to 99h (BCD encoding) for the list of protection functions F01 to F99
- The relay number field is used for protection
  - Indicates the relay involved
  - Varies from 1 to N (N being the maximum number of relays available in the Sepam) and may never be equal to 0

Exception Reply

In addition to the usual cases, Sepam realys can send type 07 exception replies (not acknowledged) if:

- Another remote reading or setting request is being processed
- The remote setting function is blocked

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Reply Frame
The reply sent back by the Sepam™ relay is the same as the remote reading reply frame. It fits into a zone containing a maximum of 125 words at the address 2000h and is composed of the effective settings of the function following a semantic check:

2000h-207Ch

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function Code								Relay Number							
Settings															
.....															
(Special Field for Each Function)															
.....															

This zone is read by a "read n words" operation (function 3) at the address 2000h. The length of the exchange may unclude:
- The first word only (validity test)
- The maximum size of the reply zone (125 words)
- The usable size of the reply zone (determined by the function being addressed)
  - Reading must always begin at the first word in the address zone (any other address triggers an exception reply "incorrect address")
  - The first word in the reply zone (function code and relay number) has the same values as those described for the remote reading reply frame

- **xxyy**
  - Function code xx different from 00 and FFh
  - Relay number yy different from FFh
    - The settings are available and validated
    - The word is a copy of the "request frame"
    - The zone contents remain valid until the next request is made
- **0000h**
  - No "request frame" has been formulated yet, as it is the case, in particular, when the Sepam is switched on
  - The other words are not significant
- **FFFFh**
  - The "request frame" has been processed, but the results in the "reply frame" are not yet available
  - It is necessary to repeat "reply frame" reading
  - The other words are not significant
- **xxFFh**
  - With function code xx different from 00 and FFh
  - The function for which the remote reading request has been made is not valid
  - The function is not included in that particular Sepam, or access to settings is impossible, both in read and write mode

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Description of Settings

Data Format

All the settings are transmitted in signed 32-bit whole number, encoded as a complement of 2.

Particular setting value:
7FFF FFFFh means that the setting is outside the validity range.

① The Enabled or Disabled setting is encoded as follows:
0 = Disabled, 1 = Enabled

② The tripping curve setting is encoded as follows:

0 = Definite	
1 = Standard Inverse Time	9 = IEC VIT/
2 = Long Time Inverse	10 = IEC EIT/C
3 = Very Inverse Time	11 = IEEE Mod. Inverse
4 = Extremely Inverse Time	12 = IEEE Very Inverse
5 = Ultra Inverse Time	13 = IEEE Extr. Inverse
6 = RI	14 = IAC Inverse
7 = IEC SIT/A	15 = IAC Very Inverse
8 = IEC LTI/B	16 = IAC Extr. Inverse

③ The setting of the timer hold curve is encoded as follows:
0 = Definite Time (DT)
1 = Inverse Definite Minimum Time (IDMT)

④ The H2 restraint variable is encoded as follows:
0 = H2 Restraint
1 = No H2 Restraint

⑤ The tripping curve setting is:
0 = DT
1 = IDMT

⑥ The negative sequence factor is:
0 = None (0)
1 = Low (2.25)
2 = Average (4.5)
3 = High (9)

⑦ Acknowledgment of the ambient temperature is encoded as follows:
0 = No
1 = Yes

⑧ Not Used

⑨ The blocking input setting is encoded as follows:
0 = No Blocking
1 = Block Recloser by Logic Input I26

⑩ Not Used

⑪ The activation mode of each of the shots is encoded as follows:
Correspondence between bit position and protection according to the table below:

Bit	Activation By
0	Inst O/C 1
1	Time-Delayed O/C 1
2	Inst O/C 2
3	Time-Delayed O/C 2
4	Inst E/F 1
5	Time-Delayed E/F 1
6	Inst E/F 2
7	Time-Delayed E/F 2

The bit status is encoded as follows:
0 = No activation by the protection
1 = Activation by the protection

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General Characteristics Settings (Read Only)

Function Number: 3002

Setting	Data	Format/Unit
1	Rated Frequency	0 = 50 Hz 1 = 60 Hz
2	Remote Setting Enabled	1 = Disabled
3	Sepam™ Working Language	0 = English 1 = Customized Language
4	Number of Period Before disturbance Recording	1
5	Active Setting Group	0 = Setting Group A 1 = Setting Group B 2 = setting Group A and B 3 = Choice by Input I13 4 = Choice by Remote Control 5 = Zone Selective Interlocking
6	Setting Mode	0 = TMS 1 = 10I/Is
7	Type of Phase Current Sensor	0 = 5 A CT 1 = 1 A CT 2 = LPTC
8	Number of CT	0 = 3 CT (Ia, Ib, Ic) 1 = 2 CT (Ia, Ic)
9	Rated Current	A
10	Base Current	A
11	Residual Current Mode	0 = 3I sum 1 = 2 A rated CSH 2 = 20 A rated CSH 3 = 1 A CT 4 = 5 A CT 5 = ACE990 Range 1 6 = ACE990 Range 2
12	Rated Residual Current Ino	A
13	Integration Period	0 = 5 min 1 = 10 min 2 = 15 min 3 = 30 min 4 = 60 min
14	*Reserved*	
15	Rated Primary Voltage $V_{LL}p$	V
16	Rated Secondary Voltage $V_{LL}s$	0 = 100 V 1 = 110 V 2 = 115 V 3 = 120 V 4 = 200 V 5 = 230 V
17	Voltages Measured by VT	0 = 3 VTs (Van, Vbn, Vcn) 1 = 2 VTs (Vab, Vbc) 2 = 1 VT (Vab)
18	Residual Voltage Mode	0 = None 1 = 3 V sum 2 = External VT – $V_{LL}s/\sqrt{3}$ 3 = External VT – $V_{LL}s/3$

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Protection Settings

They are organized according to increasing ANSI codes.

ANSI 27 - Phase-to-Phase Undervoltage

Function Number: 10xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	Enabled or Disabled	(1)
2	Vs Set Point	% $V_{LL}p$
3	Tripping Time Delay	10 ms
4–8	*Reserved*	

ANSI 27D/47 - Positive Sequence Undervoltage

Function Number: 08xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	Enabled or Disabled	(1)
2	Vs1 Set Point	% $V_{LL}p$
3	Tripping Time Delay	10 ms
4–8	*Reserved*	

ANSI 27R - Remanent Undervoltage

Function Number: 0901

Setting	Data	Format/Unit
1	Enabled or Disabled	(1)
2	Vs Set Point	% $V_{LL}p$
3	Tripping Time Delay	10 ms
4–8	*Reserved*	

ANSI 27S - Phase-to-Neutral Undervoltage

Function Number: 1801

Setting	Data	Format/Unit
1	Enabled or Disabled	(1)
2	Vs Set Point	% $V_{Ln}p$
3	Tripping Time Delay	10 ms
4–8	*Reserved*	

ANSI 37 - Phase Undercurrent

Function Number: 0501

Setting	Data	Format/Unit
1	Enabled or Disabled	(1)
2	Is Set Point	% IB
3	Tripping Time Delay	10 ms

ANSI 38/49T - Temperature Monitoring

Function number: 15xx
Relay 1 : xx = 01
Relay 2 : xx = 02
Relay 3 : xx = 03
Relay 4 : xx = 04
Relay 5 : xx = 05
Relay 6 : xx = 06
Relay 7 : xx = 07
Relay 8 : xx = 08

Setting	Data	Format/Unit
1	Enabled or Disabled	(1)
2	Alarm Set Point	° C
3	Trip Set Point	° C
4–8	*Reserved*	

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ANSI 46 - Negative Sequence/Unbalance
Function Number: 0301

Setting	Data	Format/Unit
1	Enable or Disabled	①
2	Tripping Curve	⑤
3	Is Set Point	% I_B
4	Tripping Time Delay	10 ms

ANSI 48/51LR/14 - Locked Rotor, Excessive Starting Time
Function Number: 0601

Setting	Data	Format/Unit
1	Enabled or Disabled	①
2	Is Set Point	% IB
3	Excessive Starting Time Delay (ST)	10 ms
4	Locked Rotor Time Delay (LT)	10 ms
5	Locked Rotor on Start Time Delay (LTS)	10 ms

ANSI 49RMS - Thermal Overload
Function Number: 0401

Setting	Data	Format/Unit
1	Enable or Disabled	①
2	Negative Sequence Factor	⑥
3	Is Set Point for Switching from Group A/Group B	% I_B
4	Accounting for Ambient Temperature	⑦
5	Maximum Equipment Temperature	° C
6	*Reserved*	
7	*Reserved*	
8	Group A - Heat Rise Alarm Set Point	%
9	Group A - Heat Rise Tripping Set Point	%
10	Group A - Heating Time Constant	min
11	Group A - Cooling Time Constant	min
12	Group A - Initial Heat Rise Value	%
13	Group B - Enabled or Disabled	①
14	Group B - Heat Rise Alarm Set Point	%
15	Group B - Heat Rise Tripping Set Point	%
16	Group B - Heating Time Constant	min
17	Group B - Cooling Time Constant	min
18	Group B - Initial Heat Rise Value	%

ANSI 50/51 - Phase Current
Function Number: 01xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	*Reserved*	
2	Group A - Tripping Curve	②
3	Group A - Is Set Point	0.1 A
4	Group A - Tripping Time Delay	10 ms
5	Group A - Timer Hold Curve	③
6	Group A - Timer Hold Delay	10 ms
7	*Reserved*	
8	*Reserved*	
9	ON/OFF	①
10	Group B - Tripping Curve	②
11	Group B - Is Set Point	0.1 A
12	Group B - Tripping Time Delay	10 ms
13	Group B - Timer Hold Curve	③
14	Group B - Timer Hold Delay	10 ms
15	*Reserved*	
16	*Reserved*	

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ANSI 50BF - Breaker Failure
Function Number: 2101

Setting	Data	Format/Unit
1	ON or OFF	①
2	Is Set Point	0.1 A
3	Tripping Time Delay	10 ms
4	Use Close Position of Circuit Breaker	0 = No 1 = Yes

ANSI 50N/51N or 50G/51G - Ground Fault
Function Number: 02xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	*Reserved*	
2	Group A - Tripping Curve	②
3	Group A - Isr Set Point	0.1 A
4	Group A - Tripping Time Delay	10 ms
5	Group A - Timer Hold Curve	③
6	Group A - Timer Hold Delay	10 ms
7	Group A - H2 Restraint	④
8	*Reserved*	
9	ON/OFF	①
10	Group B - Tripping Curve	②
11	Group B - Isr Set Point	0.1 A
12	Group B - Tripping Time Delay	10 ms
13	Group B - Timer Hold Curve	③
14	Group B - Timer Hold Delay	10 ms
15	Group B - H2 Restraint	④
16	*Reserved*	

ANSI 59 - Phase-to-Phase Overvoltage
Function Number: 11xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	Enabled or Disabled	①
2	Vs Set Point	% $V_{LL}p$
3	Tripping Time Delay	10 ms
4 to 8	*Reserved*	

ANSI 59N - Neutral Voltage Displacement
Function Number: 12xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	Enabled or Disabled	①
2	Vsr Set Point	% $V_{LL}p$
3	Tripping Time Delay	10 ms
4–8	*Reserved*	

ANSI 66 - Starts per Hour
Function Number: 0701

Setting	Data	Format/Unit
1	Enabled or Disabled	①
2	Period of Time	hrs
3	Total Number of Starts	1
4	Number of Consecutive Hot Starts	1
5	Number of Consecutive Starts	1
6	Time Delay between Starts	min

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ANSI 79 - Recloser Function
Function Number: 1701

Setting	Data	Format/Unit
1	Recloser – Enabled or Disabled	①
2	Recloser Blocked by Input I26	⑨
3	Number of Shots	1–4
4	Recloser – Reclaim Time Delay	10 ms
5	Recloser – Blocking Time Delay	10 ms
6	*Reserved*	
7	Step 1 – Activation Mode	⑪
8	Step 1 – Isolation Time Delay	10 ms
9	*Reserved*	
10	Step 2 – Activation Mode	⑪
11	Step 2 – Isolation Time Delay	10 ms
12	*Reserved*	
13	Step 3 – Activation Mode	⑪
14	Step 3 – Isolation Time Delay	10 ms
15	*Reserved*	
16	Step 4 – Activation Mode	⑪
17	Step 4 – Isolation Time Delay	10 ms

ANSI 81H - Overfrequency
Function Number: 1301

Setting	Data	Format/Unit
1	Enabled or Disabled	①
2	Fs Set Point	0.1 Hz
3	Tripping Time Delay	10 ms
4 to 8	*Reserved*	

ANSI 81L - Underfrequency
Function Number: 14xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	Enabled or Disabled	①
2	Fs Set Point	0.1 Hz
3	Tripping Time Delay	10 ms
4 to 8	*Reserved*	

ANSI 81R - Rate of Change of Frequency
Function Number: 1601

Setting	Data	Format/Unit
1	Enabled or Disabled	①
2	dFs/dt Set Point	0.1 Hz/s
3	Tripping Time Delay	10 ms
4 to 8	*Reserved*	

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Presentation

The disturbance recording function is used to record analog and logical signals during a time interval. Sepam™ Series 20 can store two records. Each record is comprised of two files:

- Configuration file with suffix **.CFG**
- Data file with suffix **.DAT**

The data of each record may be transferred via the Modbus link. It is possible to transfer 1 or 2 records to a remote monitoring and control system. The record may be transferred as many times as possible, until it is overwritten by a new record.

If a record is made by Sepam while the oldest record is being transferred, the oldest record is altered. If a command (e.g., a remote reading or remote setting request) is carried out during the transfer of a disturbance recording record, the record is not disturbed.

Time-Setting

Each record can be dated. Time-setting of Sepam is described in the "Time-tagging of events" section.

Transferring Records

The transfer requests are made record by record, i.e. one configuration file and one data file per record. The master sends the commands in order to:

- Find out the characteristics of the records stored in an identification zone
- Read the contents of the different files
- Acknowledge each transfer
- Re-read the identification zone to ensure that the record still appears in the list of records available

Reading the Identification Zone

Given the volume of data to be transmitted, the master must ensure that there are data to be recovered and prepare the exchanges when necessary. The identification zone, described below, is read by the reading of N words starting at the address 2204h (these data are consecutive):

- 2 reserve words forced to 0
- Size of record configuration files encoded in 1 word
- Size of record data files encoded in 1 word
- Number of records encoded in 1 word
- Date of record (most recent) encoded in 4 words (see format below)
- Date of record (least recent) encoded in 4 words (see format below)
- 24 reserve words

Reading the Contents of the Different Files

Request Frame

The master makes the request by writing the date of the record to be transferred (function 16) in 4 words starting at the address 2200h.

Note: *Requesting a new record amounts to stopping the transfers which are in progress. This is not the case for an identification zone transfer request.*

2200h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
O	O	O	O	O	O	O	O	Y	Y	Y	Y	Y	Y	Y	Y
O	O	O	O	M	M	M	M	O	O	O	D	D	D	D	D
O	O	O	H	H	H	H	H	O	O	mn	mn	mn	mn	mn	mn
ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms

- **Y** - Years
  - 1 Byte
  - 0–99 years
  - The master must ensure that the year 00 is later than 99
- **M** - Months
  - 1 Byte
  - 1–12
- **D** - Days
  - 1 Byte
  - 1–31
- **H** - Hours
  - 1 Byte
  - 0–23
- **mn** - Minutes
  - 1 Byte
  - 0–59
- **ms** - Milliseconds
  - 2 Bytes
  - 0–59999

Reply Frame

Reading of each portion of configuration and data file records by a reading frame (function 3) of 125-words starting at the address 2300h.

2300h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Exchange Number								Number of Usable Bytes in the Data Zone							
.....															
Data Zone															
.....															

Reading should always begin with the first word in the address zone (any other address triggers an exception reply "incorrect address").

The configuration and data files are read in their entirety in Sepam. They are transferred adjacently.

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If the master requests more exchanges than necessary, the exchange number remains unchanged and the number of usable bytes is forced to 0. To guarantee the data transfers, it is necessary to allow a response time of about 500 ms between each reading operation at 2300h.

The first word transmitted is an exchange word. The exchange word comprises two fields:
- **Most Significant Byte** contains the exchange number. It is incremented by 1 by the Sepam™ relay each time a successful transfer takes place. When it reaches the value FFh, it automatically resets to zero.
- **Least Significant Byte** contains the number of usable bytes in the data zone. It is initialized to zero after energizing and must be different from FFh.

The exchange word may also have the following values:
- **xxyy**: the number of usable bytes in the data zone yy must be different from FFh
- **0000h**: no "read request frame" has been formulated yet, as it is the case in particular, when the Sepam is switched on. The other words are not significant,
- **FFFFh**: the "request frame" has been processed, but the results in the reply zone are not yet available.

It is necessary to repeat "reply frame" reading. The other words are not significant. The words which follow the exchange word make up the data zone. Since the configuration and data files are adjacent, a frame may contain the end of the configuration file and the beginning of the data file of a record.

It is up to the remote monitoring and control system software to reconstruct the files in accordance with the transmitted number of usable bytes and the size of the files indicated in the identification zone.

Acknowledging a Transfer
To inform the Sepam that a record block that it has just read has been received correctly, the master must write the number of the last exchange that it has carried out in the "exchange number" filed and set the "number of usable bytes in the data zone" of the exchange word to zero.

The Sepam only increments the exchange number if new acquisition bursts are present.

Rereading the Identification Zone
To ensure that the record has not been modified, during its transfer by a new record, the master rereads the contents of the identification zone and ensures that the recovered record date is still present.

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Safety Instructions
Before Starting

This page contains important safety instructions that must be followed precisely before attempting to install, repair, service or maintain electrical equipment. Carefully read and follow the safety instructions described below.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Handling this product requires expertise in the field of electrical network protection. Only competent, qualified personnel should install or maintain this equipment. Such work should be performed only after reading this entire instruction set.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Before performing visual inspections, tests, or maintenance on this equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested and tagged. Pay particular attention to the power system design. Consider all sources of power, including the possibility of backfeeding.
- Beware of potential hazards, carefully inspect the work area for tools and objects that may have been left inside the equipment.
- Wear properly-rated personal protective equipment.
- The successful operation of this equipment depends upon proper handling, installation, and operation. Neglecting fundamental installation requirements can lead to personal injury as well as damage to electrical equipment or other property.
- Before performing Dielectric (Hi-Pot) or Megger testing on any equipment in which the relay is installed, disconnect all input and output wires to the relay. High voltage testing can damage electronic components contained in the Sepam™ relay unit.

Failure to follow these instructions will result in death or serious injury.

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Precautions

We recommend that you follow the instructions given in this document for quick, correct installation of your Sepam™ unit:

- *Equipment Identification*
- *Assembly*
- *Connection of Inputs, Current, Voltage and Sensors*
- *Connection of Power Supply*
- *Checking prior to Commissioning*

Handling, Transport, and Storage

Sepam Relay in Its Original Packaging

Transport
Sepam relays can be shipped to any destination by all usual means of transport without taking additional precautions.

Handling
Sepam relays can be handled without any particular care and can even withstand being dropped by a person standing at floor-level.

Storage
Sepam relays can be stored in its original packaging, in an appropriate location for several years:

- Temperature between -13°F and +158°F (-25°C and +70°C)
- Humidity ⩽ 90%

Periodic, yearly checking of the environment and the packaging condition is recommended. Once Sepam has been unpacked, it should be energized as soon as possible.

Sepam Installed in a Cubicle

Transport:
Sepam can be transported by all usual means of transport in the customary conditions used for cubicles. Storage conditions should be taken into consideration for a long period of transport.

Handling:
Should the Sepam fall out of a cubicle, check its condition by visual inspection and energizing.

Storage:
Keep the cubicle protection packing for as long as possible. Sepam, like all electronic units, should not be stored in a damp environment for more than a month. Sepam should be energized as quickly as possible. If this is not possible, the cubicle heating system should be activated.

Environment of the Installed Sepam

Operation in a Damp Environment
The temperature/relative humidity factors must be compatible with the unit's environmental withstand characteristics.
If the use conditions are outside the normal zone, special arrangements should be made before commissioning, such as air conditioning of the premises.

Operation in a Polluted Atmosphere
A contaminated industrial atmosphere (such as the presence of chlorine, hydrofluoric acid, sulfur, solvents, etc.) can cause corrosion of the electronic components, in which case environmental control arrangements should be made (such as pressurized premises with filtered air, etc.) before commissioning.
The effect of corrosion on Sepam has been tested according to the IEC 60068-2-60 standard. Sepam is certified level C under the following test conditions:

- 2 Gas test: 21 days, 25°C (77°F), 75% relative humidity, 0.5 ppm H_2S, 1 ppm SO_2
- 4 Gas test: 21 days, 25°C (77°F), 75% relative humidity, 0.01 ppm H_2S, 0.2 ppm SO_2, 0.2 ppm NO_2, 0.01 ppm Cl_2

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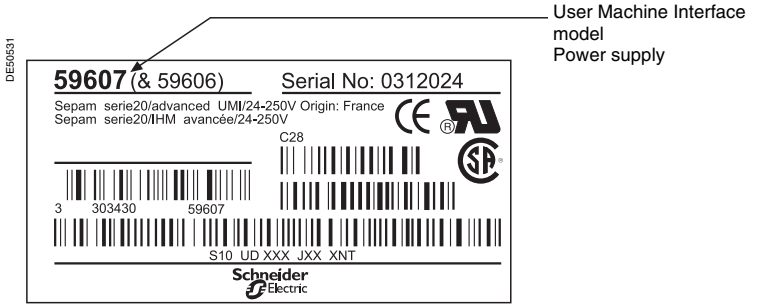
Equipment Identification

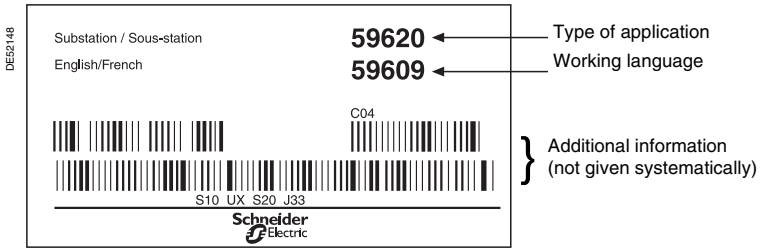
Identification of the Base Unit

Each Sepam™ comes in a single package which contains
the base unit and the base unit 20-pin connector (CCA620 or CCA622).
The other optional accessories such as modules, current or voltage input connectors and cords come in separate packages.
To identify a Sepam, check the 2 labels on the right side panel of the base unit describing the product's functional and hardware features.

■ Hardware reference and designation label



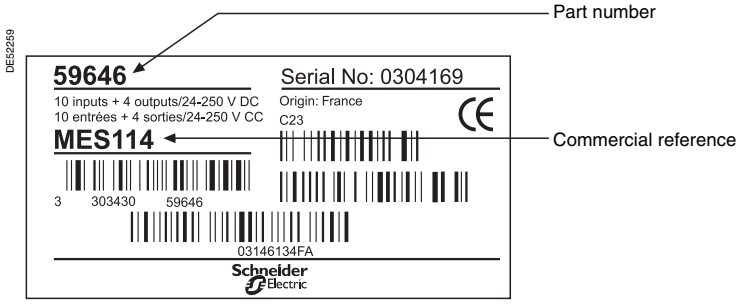
■ Functional reference and designation label



Identification of Accessories

The accessories such as optional modules, current or voltage connectors and connection cords come in separate packages, which are identified by labels.

■ Example of MES114 module identification label:



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Equipment Identification

List of Sepam™ Series 20 References

Reference	Description
DSM303	Remote Advanced UMI Module
SQ1S20A	Substation Application Type S20
SQ1T20A	Transformer Application Type T20
SQ1M20A	Motor Application Type M20
SQ1B21A	Bus Application Type B21
SQ1B22A	Bus Application Type B22
SQ1S23A	Substation Application Type S23
SQ1T23A	Transformer Application Type T23
CCA634	Connector for 1 A/5 A CT + I0 Current Sensors
CCA630	Connector for 1 A/5 A CT Current Sensors
CCA670	Connector for LPCT Current Sensors
CCA640	Connector for VT Voltage Sensors
CSH30	Interposing Ring CT for I0 Input
CSH120	Residual Current Sensor, Diameter 4.7 in (120 mm)
CSH200	Residual Current Sensor, Diameter 7.9 in (200 mm)
AMT852	Lead Sealing Accessory MET1482
MET1482	8-Temperature Sensor Module
ACE9492	2-Wire RS485 Network Interface
ACE959	4-Wire RS485 Network Interface
ACE937	Optical Fiber Interface
MES114	10 Input + 4 Output Module/24-250 V DC (1)
MSA141	1 Analog Output Module
ACE9092	RS485/RS232 Converter
ACE919CA	RS485/RS485 Interface (AC Power Supply)
ACE919CC	RS485/RS485 Interface (DC Power Supply)
MES114E	10 input + 4 Output Module/110-125 V DC and V AC
CCA770	Remote Module Connection Cord, L = 2 ft (0.6 m)
CCA772	Remote Module Connection Cord, L = 6.6 ft (2 m)
CCA774	Remote Module Connection Cord, L = 13 ft (4 m)
CCA612	Communication Network interface Cord, L = 9.8 ft (3 m)
CCA783	PC Connection Cord
CCA613	LPCT Test Plug
ACE917	LPCT Injection Adapter
CCA620	20-pin Screw Type Connector
CCA622	20-pin Ring Lug Connector
AMT840	Mounting Plate for DSM303
ACE990	Zero Sequence CT Interface for I0 Input
Kit 2640	2 Sets of Spare Connectors
SFT2841	CD-ROM with SFT2841 and SFT2826 Software Without CCA783 Cord
ACE969	TP 2-Wire RS485 Multi-Protocol Interface (Modbus, DNP3 or IEC 60870-5-103)
ACE969	FO Fiber-Optic Multi-Protocol Interface (Modbus, DNP3 or IEC 60870-5-103)

(1) *List of cancelled references and their replacements:*

- 59602 (base unit with basic UMI, 24 V DC power supply) cancelled and replaced by reference 59603
- 59606 (base unit with advanced UMI, 24 V DC power supply) cancelled and replaced by reference 59607
- 59645 (MES108 4I/4O module) cancelled and replaced by reference 59646

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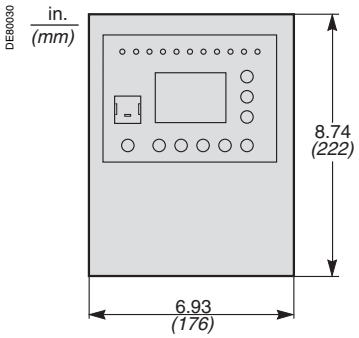
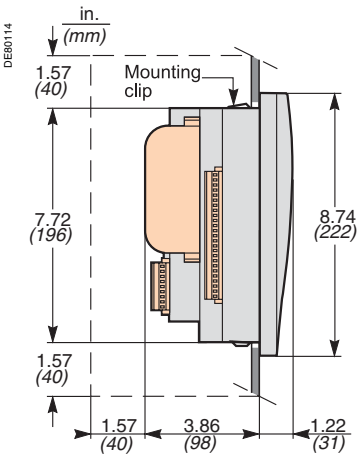
Base Unit
Dimensions

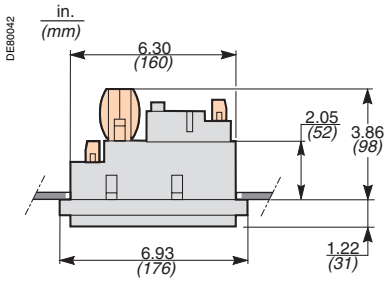
Dimensions



Front view of Sepam™ Relay



Sepam Relay with Advanced UMI and MES114, Flush-Mounted in Front Panel



Sepam Relay with Advanced UMI and MES114, Flush-Mounted in Front Panel

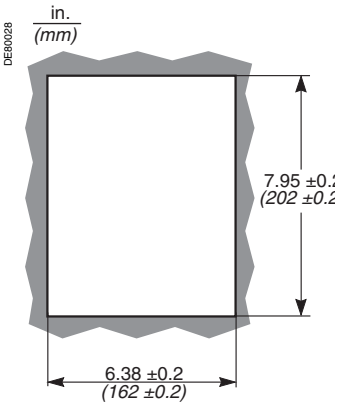
***(1)** With Basic UMI: 0.91 in (23 mm).*

Clearance for Sepam Assembly and Wiring

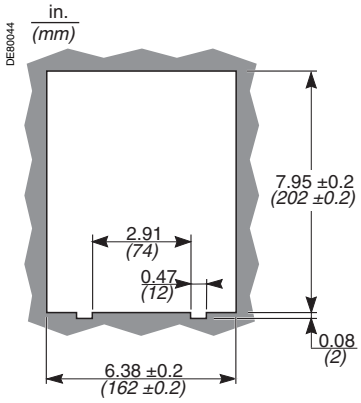
Cut-Out

Cut-out accuracy must be complied with to ensure good withstand.

For mounting plate between 1.5 mm (0.059 in) and 3 mm (0.12 in) thick



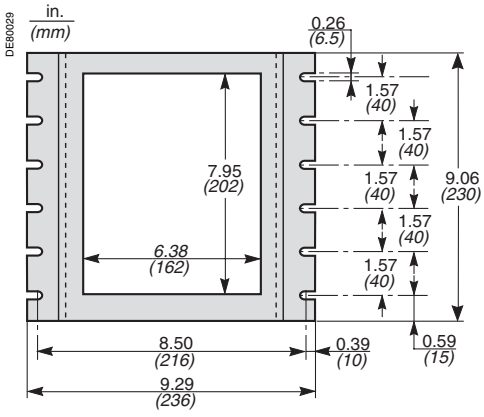
For mounting plate 3.17 mm (0.125 inch) thick



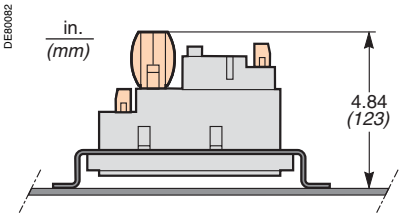
> **⚠ CAUTION**
>
> **HAZARD OF CUTS**
>
> Trim the edges of the cut-out plates to remove any jagged edges.
>
> **Failure to follow this instruction can cause serious injury.**

Assembly with AMT840 Mounting Plate

Used to mount the Sepam™ relay with basic UMI at the back of the compartment with access to the connectors on the rear panel. Mounting associated with the use of the remote advanced UMI (DSM303).



AMT840 Mounting Plate



Sepam Relay with Basic UMI and MES114, Mounted with AMT840 Plate
Mounting Plate Thickness: 0.079 in (2 mm)

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Base Unit
Assembly

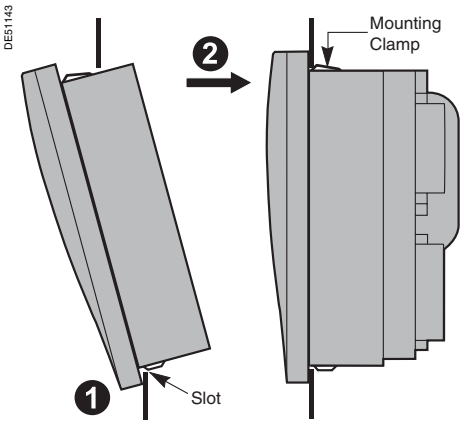
⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.

Failure to follow these instructions will result in death or serious injury.

The Sepam™ relay is simply flush-mounted and secured by its clips. No additional screw type fastening is required.



(1) Present the product as indicated, making sure the metal plate is correctly entered in the groove at the bottom.

(2) Tilt the product and press on the top part to clamp it with the clips.

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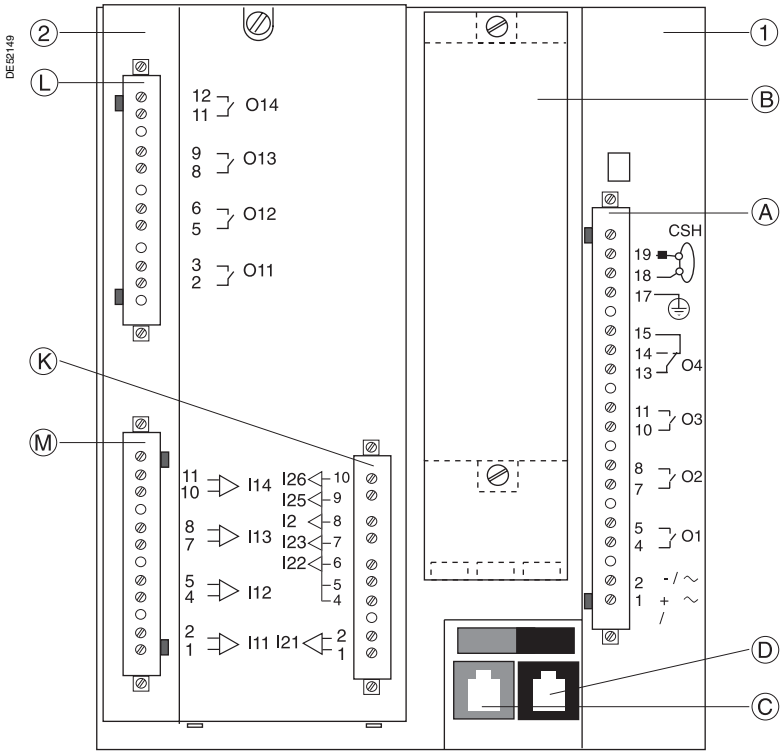
Base Unit
Description

Sepam™ Components

- Base Unit (1)
  - (A) Base Unit Connector:
    - Power Supply
    - Output Relays
    - CSH30, 120, 200 or ACE990 Input
    - Screw-Type Connector Shown (CCA620), or Ring Lug Connector (CCA622)
  - (B) 1 A/5 A CT Current Input Connector (CCA630 or CCA634), or LPCT Current Input Connector (CCA670), or VT Voltage Input Connector (CCT640)
  - (C) Communication Module Link Connection (white)
  - (D) Remote Inter-Module Link Connection (black)
- Optional input/output module (2) (MES114)
  - (L) (M) MES114 Module Connectors
  - (K) MES114 Module Connector



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Base Unit
Connection

Connection of the Base Unit

The Sepam™ connections are made to the removable connectors located on the rear panel. All the connectors are screw-lockable.

⚠ CAUTION

LOSS OF PROTECTION OR RISK OF NUISANCE TRIPPING

If the Sepam is no longer supplied with power or is in fail-safe position, the protection functions are no longer active and all the Sepam output relays are dropped out. Check that this operating mode and the watchdog relay wiring are compatible with your installation.

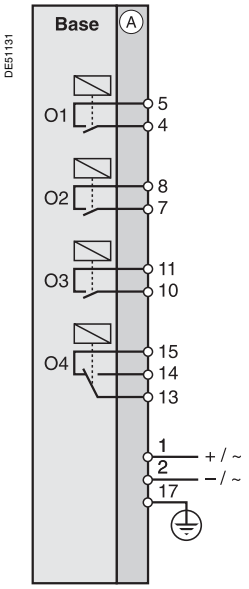
Failure to follow this instruction can result in equipment damage and unwanted shutdown of the electrical installation

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

Failure to follow these instructions will result in death or serious injury.



Wiring of the CCA620 connector:

- Without fitting
  - 1 wire with maximum cross-section of AWG 24-12 (0.2–2.5 mm^2) or 2 wires with maximum cross-section of AWG 24-18 (0.2–1 mm^2)
  - Stripped length: 0.31–0.39 in (8–10 mm)
- With fitting
  - Recommended wiring with Telemecanique fitting:
    - DZ5CE015D for 1 wire 0.0023 in^2 (1.5 mm^2), AWG 16
    - DZ5CE025D for 1 wire 0.0039 in^2 (2.5 mm^2), AWG 12
    - AZ5DE010D for 2 wires 0.0016 in^2 (1 mm^2), AWG 18
  - Cable length: 0.32 in (8.2 mm)
  - Stripped length: 0.31 in (8 mm)

Wiring of the CCA622 connector:

- Ring lug connectors 1/4 in (6.35 mm)

Characteristics of the 4 base unit relay outputs O1, O2, O3, O4

- O1 and O2 are 2 control outputs, used by the breaking device control function for:
  - O1: Breaking device tripping
  - O2: Breaking device block closing
- O3 and O4 are indication outputs, only O4 can be activated by the watchdog function

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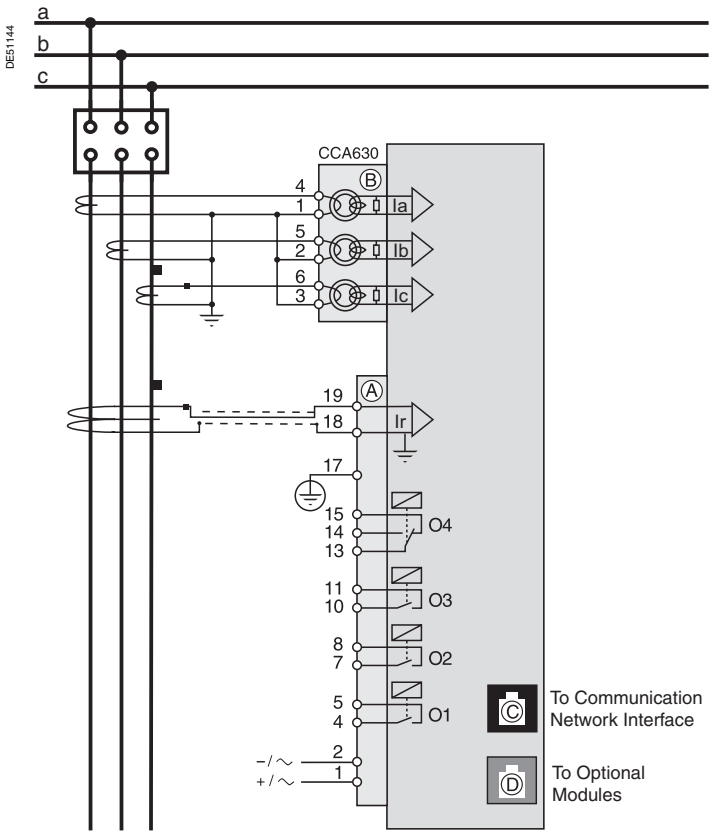
Base Unit
Connection of Current Inputs



Types S20/S23/T20/T23/M20

Connection to 1 A/5 A current sensors

Connector	Type	Ref.	Cable
A	Screw-Type	CCA620	1 wire 0.0003–0.0039 in^2 (0.2–2.5 mm^2) AWG 24-12 2 wires 0.0003–0.0016 in^2 (0.2–1 mm^2) AWG 24-18
	Ring Lug 0.25 in (6.35 mm)	CCA622	
B	Ring Lug 0.16 in (4 mm)	CCA630/ CCA634	0.0023–0.0093 in^2 (1.5–6 mm^2) AWG 16-10
C	RJ45		CCA612
D	RJ45		CCA770: L = 2 ft (0.6 m) CCA772: L = 6.6 ft (2 m) CCA774: L = 13 ft (4 m)

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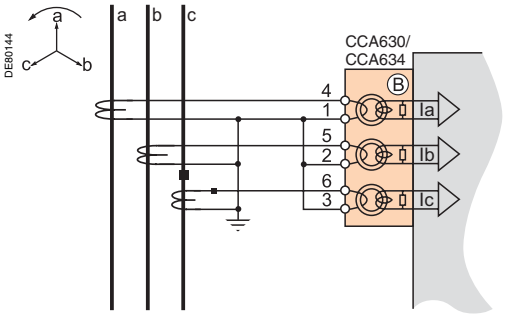
Base Unit
Other Phase Current Input Connection Schemes

Variant 1: Phase Current Measurements by 3 x 1 A or 5 A CTs (standard connection)



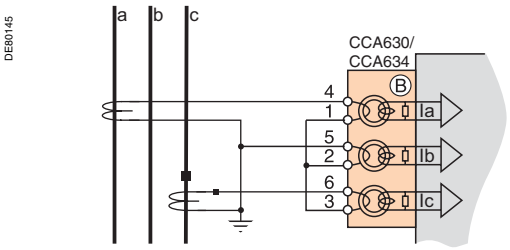
Description
Connection of 3 x 1 A or 5 A sensors to the CCA630 or CCA634 connector.

The measurement of the 3 phase currents allows the calculation of residual current.

Parameters

Sensor Type	5 A CT or 1 A CT
Number of CT	Ia, Ib, Ic
Rated Current (IN)	1 A to 6250 A

Variant 2: Phase Current Measurement by 2 x 1 A or 5 A CTs



Description
Connection of 2 x 1 A or 5 A sensors to the CCA630 or CCA634 connector.

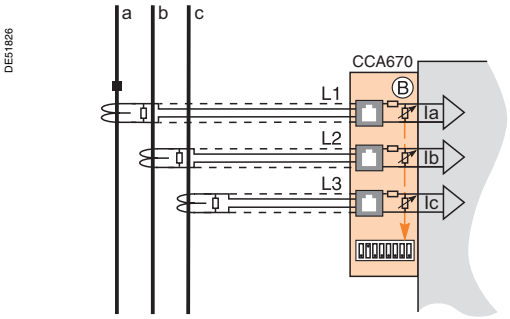
The measurement of phase currents 1 and 3 is sufficient to ensure all the phase current-based protection functions. The phase current Ib is only assessed for metering functions, assuming that Ir = 0.

This arrangement does not allow the calculation of residual current.

Parameters

Sensor Type	5 A CT or 1 A CT
Number of CT	Ia, Ic
Rated Current (IN)	1 A to 6250 A

Variant 3: Phase Current Measurement by 3 LPCT Type Sensors



Description
Connection of 3 Low Power Current Transducer (LPCT) type sensors to the CCA670 connector. The connection of only one or two LPCT sensors is not allowed and causes the Sepam™ relay to go into the fail-safe position.

The measurement of the 3 phase currents allows the calculation of residual current.

Parameters

Sensor Type	LPCT
Number of CT	Ia, Ib, Ic
Rated Current (IN)	25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000 or 3150 A

Note: *Parameter IN must be set twice:*

- *Software parameter setting using the advanced UMI or the SFT2841 software tool*
- *Hardware parameter setting using microswitches on the CCA670 connector*

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Base Unit
Other Current Input Connection Schemes

Variant 1: Residual Current Calculation by Sum of 3 Phase Currents

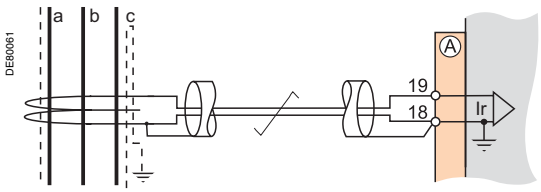
Description
Residual current is calculated by the vector sum of the 3 phase currents Ia, Ib, and Ic, measured by 3 x 1 A or 5 A CTs or by 3 LPCT type sensors.

Note: *See current input connection diagrams.*

Parameters

Residual Current	Rated Residual Current	Measuring Range
Sum of 3 Is	Inr = In, CT primary current	0.1–40 Inr

Variant 2: Residual Current Measurement by CSH120 or CSH200 Interposing Ring CT (Standard Connection)

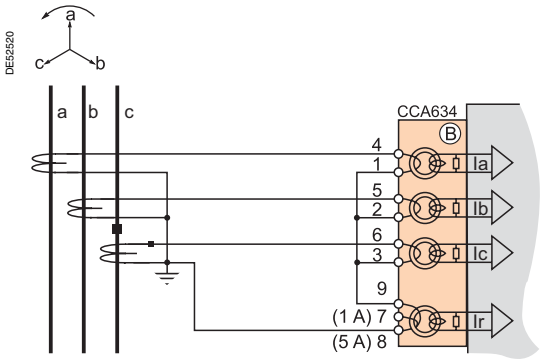


Description
Arrangement recommended for the protection of isolated or compensated neutral systems, in which very low fault currents need to be detected.

Parameters

Residual Current	Rated Residual Current	Measuring Range
2 A rating CSH	Inr = 2 A	0.2–40 A
20 A rating CSH	Inr = 20 A	2–400 A

Variant 3: Residual Current Measurement by 1 A or 5 A CTs and CCA634

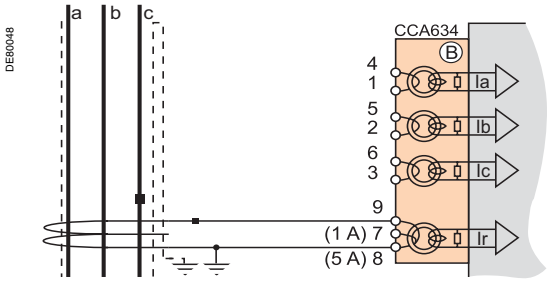


Description
Residual current measurement by 1 A or 5 A CTs.
- Terminal 7: 1 A CT
- Terminal 8: 5 A CT

Parameters

Residual Current	Rated Residual Current	Measuring Range
1 A CT	Inr = In, CT primary current	0.1–20 Inr
5 A CT	Inr = In, CT primary current	0.1–20 Inr

Note: *Inr should be thought of as a relay input port for ground fault protection. This port can accept residually connected phase CT and therefore measure positive, negative and zero sequence components. This port can also accept a zero sequence CT that measures only true zero sequence (no positive or negative sequence). So, Inr is only a port name — the kind of current (positive, negative or zero sequence) depends on the type of CT used.*



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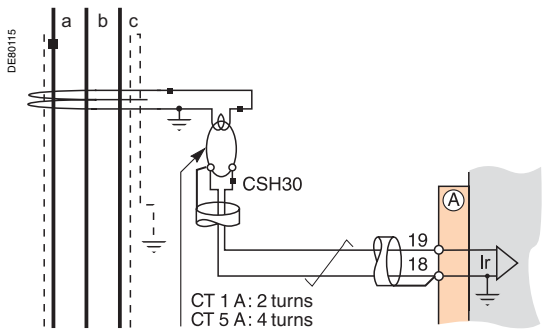
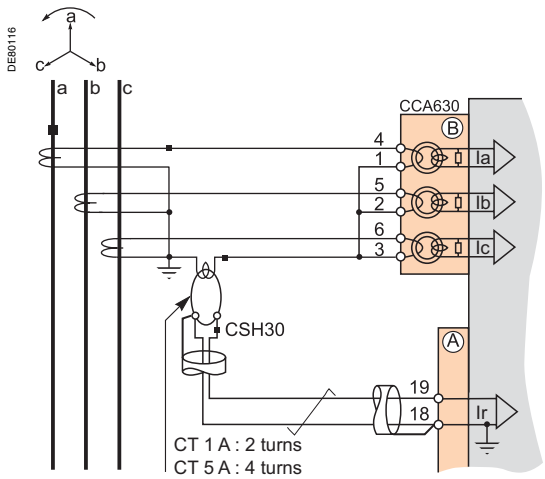
Base Unit
Other Current Input Connection Schemes

Variant 4: Residual Current Measurement by 1 A or 5 A CTs and CSH30 Interposing Ring CT





Description

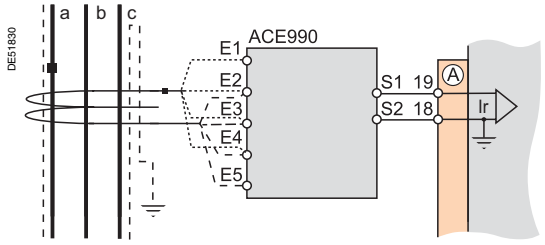
The CSH30 interposing ring CT is used to connect 1 A or 5 A CTs to a Sepam™ relay to measure residual current:

- Connection of CSH30 interposing ring CT to 1 A CT
  - Make 2 turns through CSH primary
- Connection of CSH30 interposing ring CT to 5 A CT
  - Make 4 turns through CSH primary

Parameters

Residual Current	Rated Residual Current	Measuring Range
1 A CT	I_{Nr} = I_N, CT Primary Current	0.1–20 I_{Nr}
5 A CT	I_{Nr} = I_N, CT Primary Current	0.1–20 I_{Nr}

Variant 5: Residual Current Measurement by Zero Sequence CT with Ratio of 1/n (n between 50 and 1500)



Description

The ACE990 is used as an interface between an MV zero sequence CT with a ratio of 1/n (50 < n < 1500) and the Sepam relay residual current input.

This arrangement allows the continued use of existing zero sequence CTs on the installation.

Parameters

Residual Current	Rated Residual Current	Measuring Range
ACE990 - Range 1 (0.00578 ⩽ k ⩽ 0.04)	I_{Nr} = Ik.n (1)	0.1–20 I_{Nr}
ACE990 - Range 2 (0.0578 ⩽ k ⩽ 0.26316)	I_{Nr} = Ik.n (1)	0.1–20 I_{Nr}

(1)
n = number of zero sequence CT turns
k = factor to be determined according to ACE990 wiring and setting range used by Sepam relays

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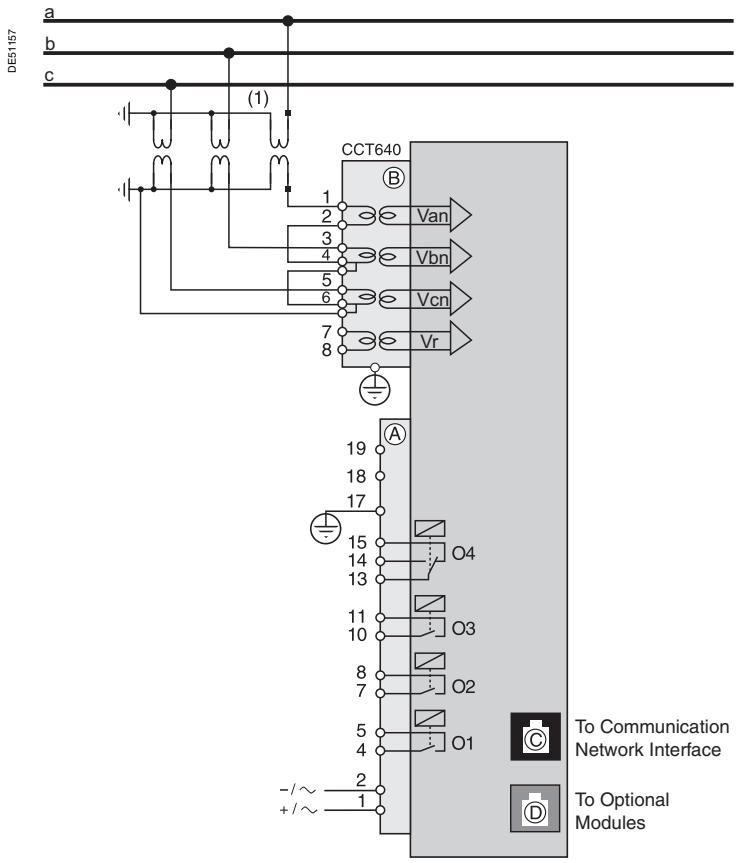
Base Unit
Connection of Voltage Inputs

B21/B22 Types



Connector	Type	Reference	Cable
A	Screw-Type	CCA620	1 wire 0.0003–0.0039 in^2 (0.2–2.5 mm^2) AWG 24-12 2 wires 0.0003–0.0016 in^2 (0.2–1 mm^2) AWG 24-18
	Ring Lug 0.25 in (6.35 mm)	CCA622	
B	Screw-Type	CCT640	1 wire 0.0003–0.0039 in^2 (0.2–2.5 mm^2) AWG 24-12 2 wires 0.0003–0.0016 in^2 (0.2–1 mm^2) AWG 24-18
C	RJ45		CCA612
D	RJ45		CCA770: L = 2 ft (0.6 m) CCA772: L = 6.6 ft (2 m) CCA774: L = 13 ft (4 m)

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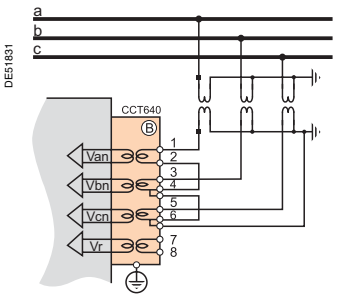
Base Unit
Other Voltage Input Connection Schemes

The phase and residual voltage transformer secondary circuits are connected to the CCT640 connector (item Ⓑ) on Sepam™ Series 20 type B units. The CCT640 connector contains 4 transformers which perform isolation and impedance matching of the VTs and Sepam input circuits.

Variant 1: Measurement of 3 Phase-to-Neutral Voltages (Standard Connection)



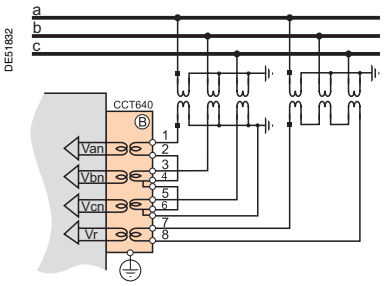
Parameters

Voltages Measured by VT	Van, Vbn, Vcn
Residual Voltage	Sum of 3Vs

Functions Available

Voltages Measured	Van, Vbn, Vcn
Values Calculated	Vab, Vbc, Vca, Vr, V1, f
Measurements Available	All
Protection Functions Available (According to Type of Sepam Relay)	All

Variant 2: Measurement of 3 Phase-to-Neutral Voltages and Residual Voltage



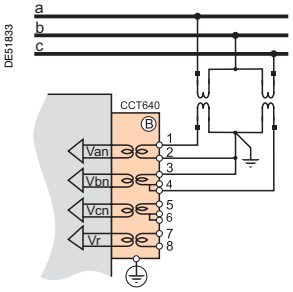
Parameters

Voltages Measured by VT	Van, Vbn, Vcn
Residual Voltage	External VT

Functions Available

Voltages Measured	V1, V2, V3, Vr
Values Calculated	Vab, Vbc, Vca, V1, f
Measurements Available	All
Protection Functions Available (According to Type of Sepam Relay)	All

Variant 3: Measurement of 2 Phase-to-Phase Voltages



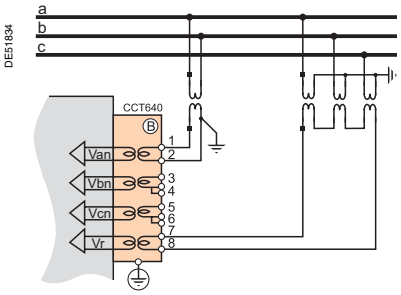
Parameters

Voltages Measured by VT	Vab, Vbc
Residual Voltage	None

Functions Available

Voltages Measured	Van, Vbn, Vcn
Values Calculated	Vca, V1, f
Measurements Available	Vab, Vbc, Vca, V1, f
Protection Functions Available (According to type of Sepam Relay)	All Except 59N, 27S

Variant 4: Measurement of 1 Phase-to-Phase Voltage and Residual Voltage



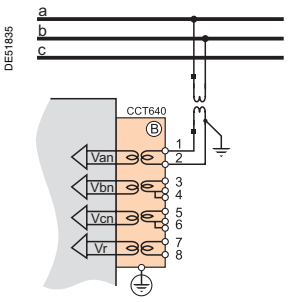
Parameters

Voltages measured by VT	Vab
Residual Voltage	External VT

Functions Available

Voltages Measured	Vab, Vr
Values Calculated	f
Measurements Available	Vab, Vr, f
Protection Functions Available (According to Type of Sepam Relay)	All Except 47, 27D, 27S

Variant 5: Measurement of 1 Phase-to-Phase Voltage



Parameters

Voltages Measured by VT	Vab
Residual Voltage	None

Functions Available

Voltages Measured	Vab
Values Calculated	f
Measurements Available	Vab, f
Protection Functions Available (According to Type of Sepam Relay)	All Except 47, 27D, 59N, 27S

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1 A/5 A Current Transformers

120R302

Function

Sepam™ relays can be connected to any standard 1 A or 5 A current transformer. Schneider Electric offers a range of current transformers to measure primary currents from 50 A to 2500 A. Please consult your local Schneider Electric sales representative for further information.

Sizing of Current Transformers

The current transformers should be large enough to minimize saturation. CT's should be selected per ANSI C37.110, which can be critical for high X/R systems and systems with generators larger than 2MW.

For Overcurrent Protection

- Definite time (DT)
  The saturation current must be more than 1.5 times the setting value
- Inverse Definite Minimum Time (IDMT)
  The saturation current must be more than 1.5 times the highest working value on the curve

Typical Applications When C37.110 Data Is Not Available

Rated Secondary Current I_N	Normal Performance				Higher Performance		
	CT Ratio (3)	Burden Designation	ANSI Class (1)	IEC Class (5)	Burden Designation	ANSI Class (2)	IEC Class (5)
5 A	100/5	B-0.1	C10	2.5 VA 5P20	B-0.2	C20	5 VA 5P20
5 A	500/5	B-0.5	C50	15 VA 5P20	B-1.0	C100	30 VA 5P20
5 A	1200/5	B-2.0	C200	50 VA 5P20	B-4.0	C400	100 VA 5P20
1 A	100/1	B-0.1	C50	2.5 VA 5P20	B-0.2	C100	5 VA 5P20
1 A	500/1	B-0.5	C200	10 VA 5P20	B-1.0	C400	30 VA 5P20
1 A	1200/1	B-2.0	C1000 (4)	40 VA 5P20	B-4.0	C2000 (4)	80 VA 5P20

(1) *Typical usual product offering from switchgear mfgs in North America for 50/51 protection.*
(2) *Generally suitable for systems with an X/R =15 or small generator is connected to bus. Minimum for 87 protection.*
(3) *CT ratio rule of thumb is to size primary to be 1.5 x connected load. (Example: 600/5 ratio. CT for 400A load.)*
(4) *Not listed in C57.13.*
(5) *Highest listed VA in IEC 60044 is 30 VA.*

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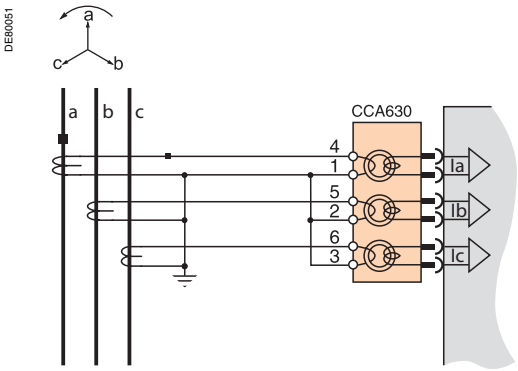

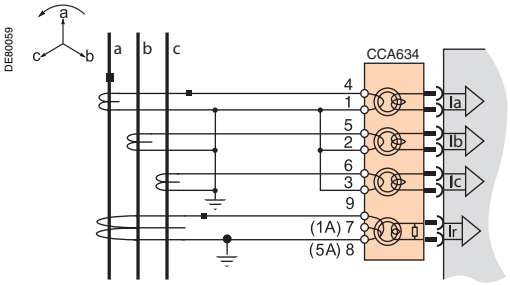

CCA630/CCA634 Connector

Function

The current transformers (1 A or 5 A) are connected to the CCA630 or CCA634 connector on the rear panel of the Sepam™ relay, with:

- The CCA630 connector used to connect 3 phase current transformers to Sepam relays
- The CCA634 connector used to connect 3 phase current transformers and a residual current transformer to Sepam relays

The CCA630 and CCA634 connectors contain interposing ring CTs with through primaries, which ensure impedance matching and isolation between the 1 A or 5 A circuits and Sepam relays when measuring phase and residual currents.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- To remove current inputs to the Sepam unit, unplug the CCA630 or CCA634 connector without disconnecting the wires from it. The CCA630 and CCA634 connectors ensure continuity of the current transformer secondary circuits.
- Before disconnecting the wires connected to the CCA630 or CCA634 connector, short-circuit the current transformer secondary circuits.

Failure to follow these instructions will result in death or serious injury.

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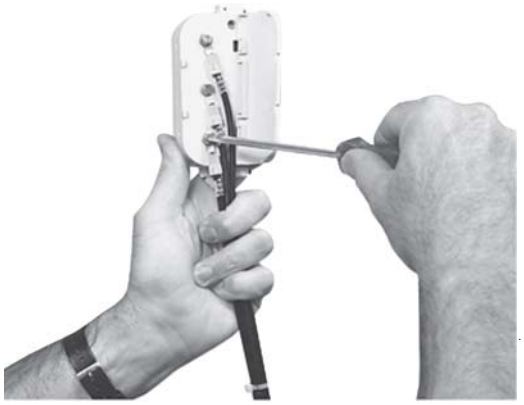
1 A/5 A Current Transformers

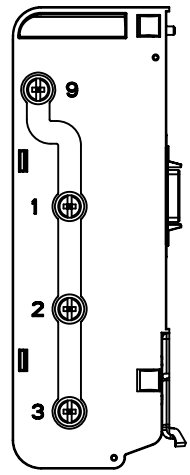
MT10490



Connecting and Assembling the CCA630 Connector

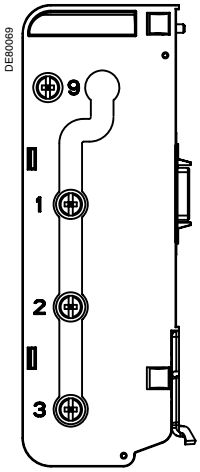
1. Open the 2 side shields to access the connection terminals. Remove the shields, if necessary, to make wiring easier. If removed, they must be replaced after wiring.
2. If necessary, remove the bridging strap linking terminals 1, 2, and 3 (supplied with CCA630).
3. Connect the wires using 0.16 in (4 mm) ring lugs and check the tightness of the 6 screws that guarantee the continuity of the CT secondary circuits.
   The connector accommodates wires with cross-sections of 0.0023–0.0093 in^2 (1.5–6 mm^2) (AWG 16-10).
4. Close the side shields.
5. Plug the connector into the 9-pin inlet on the rear panel (item Ⓑ).
6. Tighten the 2 CCA630 connector fastening screws on the rear panel of the Sepam™ relay.

DE80068



Bridging of Terminals 1, 2, 3, and 9

DE80069



Bridging of Terminals 1, 2, and 3

Connecting and Assembling the CCA634 Connector

1. Open the 2 side shields for access to the connection terminals. Remove the shields, if necessary, to make wiring easier. If removed, they must be replaced after wiring.
2. According to the wiring required, remove or reverse the bridging strap. This is used to link either terminals 1, 2 and 3, or terminals 1, 2, 3 and 9 (see picture opposite).
3. Use terminal 7 (1 A) or 8 (5 A) to measure the residual current according to the CT secondary.
4. Connect the wires using 0.16 in (4 mm) ring lugs and check the tightness of the 6 screws that guarantee the continuity of the CT secondary circuits. The connector accommodates wires with cross-sections of 0.0023–0.0093 in^2 (1.5–6 mm^2) (AWG 16-10). The wires only exit from the base.
5. Close the side shields.
6. Insert the connector pins into the slots on the base unit.
7. Flatten the connector against the unit to plug it into the 9-pin SUB-D connector (principle similar to that of the MES module).
8. Tighten the mounting screw.

⚠ CAUTION

HAZARD OF IMPROPER OPERATION

Do not use a CCA634 and residual current input (Ir) on connector A (terminals 18 and 19).

Even if it is not connected to a sensor, a CCA634 will disturb input I0 on connector A

Failure to follow this instruction can cause equipment damage.

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PE50031

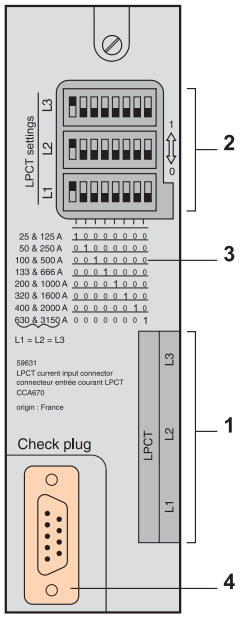
CLP1 LPCT Sensor

Function

Low Power Current Transducer (LPCT) type sensors are voltage-output sensors, that are compliant with the IEC 60044-8 standard.

The Schneider Electric range of LPCT includes the following sensors:
- CLP1
- CLP2
- CLP3
- TLP160
- TLP190.

DE51674



CCA670/CCA671 Connector

Function

The 3 LPCT sensors are connected to the CCA670 or CCA671 connector on the rear panel of Sepam™ relays (fewer than 3 sensors causes the Sepam relay to go into fail-safe position).

The two CCA670 and CCA671 interface connectors serve the same purpose, with the difference being the position of the LPCT sensor plugs:
- CCA670: Lateral plugs, for Sepam Series 20 and Sepam Series 40
- CCA671: Radial plugs, for Sepam Series 80

Description

- 3 RJ45 plugs to connect LPCT sensors
- 3 blocks of microswitches to set the CCA670/CCA671 to the rated phase current value
- Microswitch setting/selected rated current equivalency table (2 IN values per position)
- 9-pin sub-D connector to connect test equipment (ACE917 for direct connector or via CCA613)

Rating of CCA670/CCA671 Connectors

The CCA670/CCA671 connector must be rated to the rated primary current IN measured by the LPCT sensors. IN is the current value that corresponds to the rated secondary current of 22.5 mV. The possible settings for IN are: 25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000, and 3150 A.

The selected IN value should be:
- Entered as a Sepam general setting
- Configured by microswitch on the CCA670/CCA671 connector

Operating mode:
1. Use a screwdriver to remove the shield located in the "LPCT Settings" zone; the shield protects 3 blocks of 8 microswitches marked L1, L2, L3.
2. On the L1 block, set the microswitch for the selected rated current to "1" (2 IN values per microswitch).
   - The table of equivalencies between the microswitch settings and the selected rated current IN is printed on the connector
   - Leave the 7 other microswitches set to "0"
3. Set the other 2 blocks of switches L2 and L3 to the same position as the L1 block and close the shield.

⚠ CAUTION

HAZARD OF NON-OPERATION
- Set the microswitches for the CCA670/ CCA671 connector before commissioning the device.
- Check that only one microswitch is in position 1 for each block L1, L2, L3 and that no microswitch is in the center position.
- Check that the microswitch settings on all 3 blocks are identical.

Failure to follow these instructions can cause incorrect operation.

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LPCT Type Current Sensors
Test Accessories

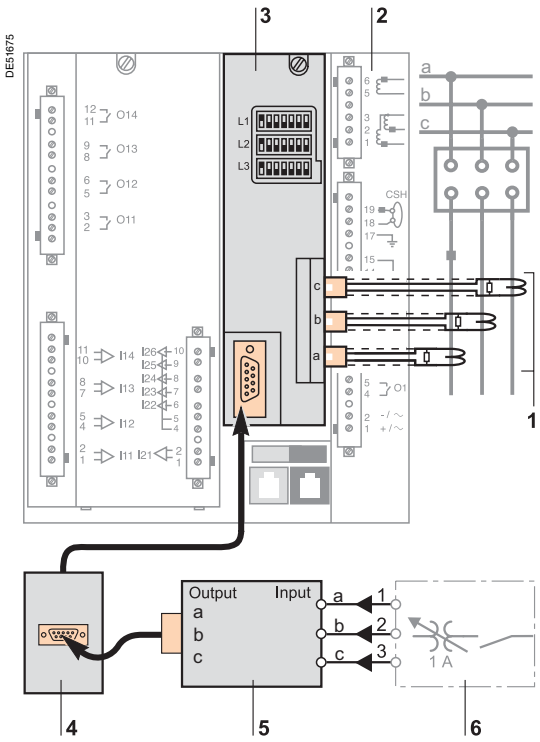
Accessory Connection Principle

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.

Failure to follow these instructions will result in death or serious injury.



- LPCT sensor, equipped with a shielded cable fitted with a yellow RJ 45 plug, is plugged directly into the CCA670/CCA671 connector
- Sepam™ protection unit
- CCA670/CCA671 connector, LPCT voltage interface, with microswitch setting of rated current:
  - CCA670: lateral plugs, for Sepam Series 20 and Sepam Series 40
  - CCA671: radial plugs, for Sepam Series 80
- CCA613 remote test plug, flush-mounted on the front of the cubicle and equipped with a 3-meter (9.8 ft) cord to be plugged into the test plug of the CCA670/CCA671 interface connector (9-pin sub-D)
- ACE917 injection adapter, to test the LPCT protection chain with a standard injection box
- Standard injection box

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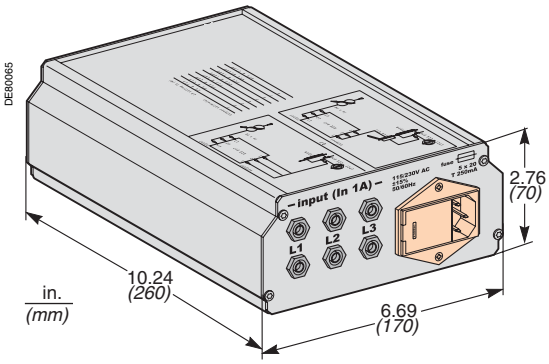
LPCT Type Current Sensors
Test Accessories



ACE917 Injection Adapter

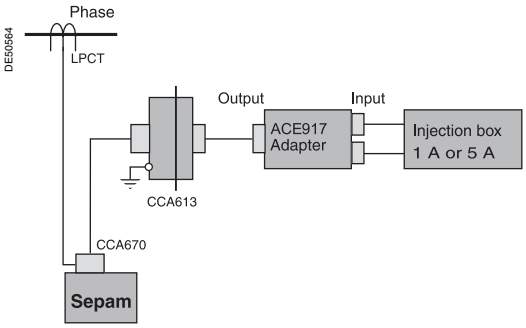
Function

The ACE917 adapter is used to test the protection chain with a standard injection box, when the Sepam™ relay is connected to LPCT sensors. It is inserted between the standard injection box and the LPCT test plug (either integrated in the Sepam CCA670/CCA671 interface connector, or transferred by means of the CCA613 accessory).

The following are supplied with the ACE917 injection adapter:
- Power supply cord
- 9.8 ft (3 m) cord to connect the ACE917 to the LPCT test plug on CCA670/CCA671 or CCA613

Characteristics

Power Supply	115/230 V AC
Protection by Time-Delayed Fuse 0.2 x 0.79 in (5 mm x 20 mm)	0.25 A Rating



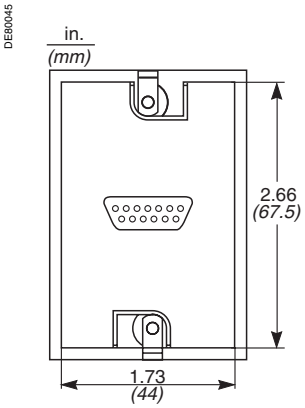
Accessory Connection Principle

CCA613 Remote Test Plug

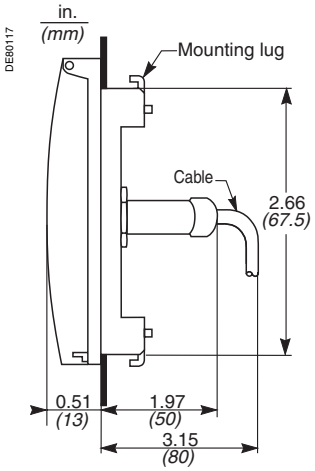
Function

The CCA613 test plug, flush-mounted on the front of the cubicle, is equipped with a 9.8 ft (3 m) cord to transfer data from the test plug integrated in the CCA670/CCA671 interface connector on the rear panel of the Sepam relay.

Dimensions



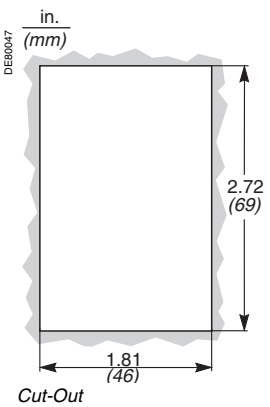
Front View with Cover Lifted



Right Side View

⚠ CAUTION

HAZARD OF CUTS
Trim the edges of the cut-out plates to remove any jagged edges.
Failure to follow this instruction can cause serious injury.



Cut-Out

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CSH120 and CSH200 Zero Sequence CT

PE50032

CSH120 and CSH200 zero sequence CT.

Function

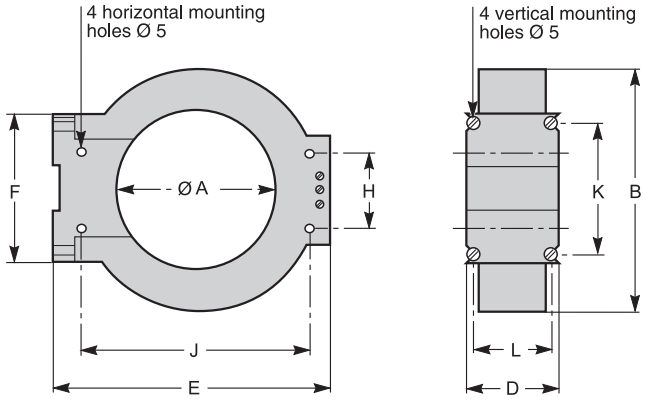
The specifically designed CSH120 and CSH200 zero sequence CT are for direct residual current measurement. The only difference between them is the diameter. Due to their low voltage insulation, they can only be used on insulated cables.

Characteristics

	CSH120	CSH200
Inner Diameter	4.7 in (120 mm)	7.9 in (200 mm)
Weight	1.32 lb (0.6 kg)	3.09 lb (1.4 kg)
Accuracy	±5% at 68° F (20° C)	
	±6% max. from -13° to +158° F (-25° to 70° C)	
Transformation Ratio	1/470	
Maximum Permissible Current	20 kA - 1 s	
Operating Temperature	-13° to +158° F (-25° to +70° C)	
Storage Temperature	-40° to +185° F (-40° to +85° C)	

Dimensions

DE10228



Dimensions	A	B	D	E	F	H	J	K	L
CSH120									
in	4.75	6.46	1.73	7.48	2.99	1.57	6.54	2.44	1.38
mm	120	164	44	190	76	40	166	62	35
CSH200									
in	7.87	10.1	1.81	10.8	4.72	2.36	10.1	4.09	1.46
mm	200	256	46	274	120	60	257	104	37

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CSH120 and CSH200 Zero Sequence CT

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Only CSH120, CSH200 and CSH280 zero sequence CT can be used for direct residual current measurement. Other residual current sensors require the use of an intermediate device, CSH30, ACE990 or CCA634.
- Install the zero sequence CT on insulated cables.
- Cables with a rated voltage of more than 1000 V must also have a grounded shielding.

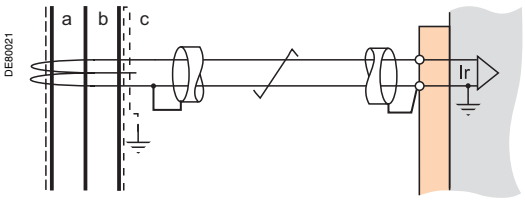
Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

HAZARD OF NON-OPERATION

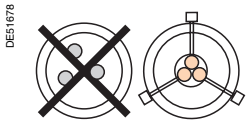
Do not connect the secondary circuit of the CSH zero sequence CT to ground. This connection is made in the Sepam™ relay.

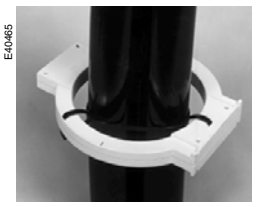
Failure to follow this instruction can cause the Sepam relay to operate incorrectly.



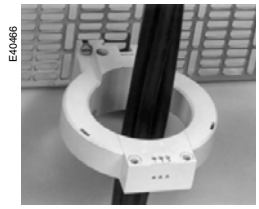
Assembly

Group the MV cable (or cables) in the middle of the zero sequence CT (Use non-conductive binding to hold the cables). Remember to insert the 3 medium voltage cable shielding grounding cables through the zero sequence CT.





Assembly on MV Cables



Assembly on Mounting Plate

Connection

Connection to Sepam™ Series 20 and Sepam Series 40

To residual current Ir input, on connector (A), terminals 19 and 18 (shielding).

Connection to Sepam Series 80

- To residual current Ir input, on connector (E), terminals 15 and 14 (shielding)
- To residual current I'r input, on connector (E), terminals 18 and 17 (shielding)

Recommended Cable

- Sheathed cable, shielded by tinned copper braid
- Minimum cable cross-section 0.0014 in² (0.93 mm²) (AWG 18)
- Resistance per unit length < 100 mΩ/m (30.5 mΩ/ft)
- Minimum dielectric strength 1000 V (700 Vrms)
- Connect the cable shielding in the shortest manner possible to the Sepam relay
- Flatten the connection cable against the metal frames of the cubicle

The connection cable shielding is grounded in the Sepam relay; do not ground by any other means.

The maximum resistance of the Sepam connection wiring must not exceed 4Ω (i.e., 66 ft maximum for 30.5 mΩ/ft or 20 m maximum for 100 mΩ/m).

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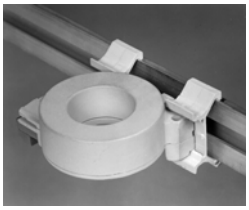
CSH30 Interposing Ring CT

E40468

Vertical Assembly of CSH30 Interposing Ring CT

E44717



Horizontal Assembly of CSH30 Interposing Ring CT

Function

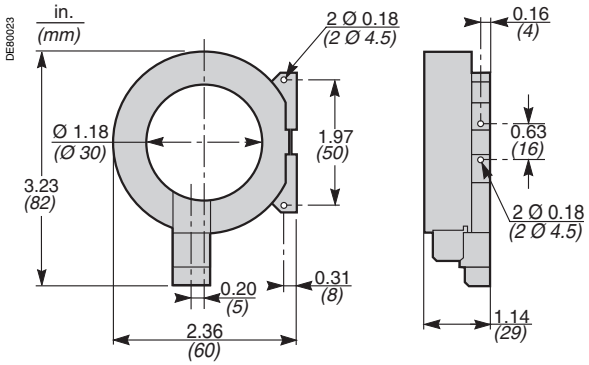
The CSH30 interposing ring CT is used as an interface when the residual current or zero sequence is measured using 1 A or 5 A current transformers.

Characteristics

Weight	0.265 lb (0.12 kg)
Assembly	On symmetrical DIN rail in vertical or horizontal position

Dimensions

DE80023



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CSH30 Interposing Ring CT

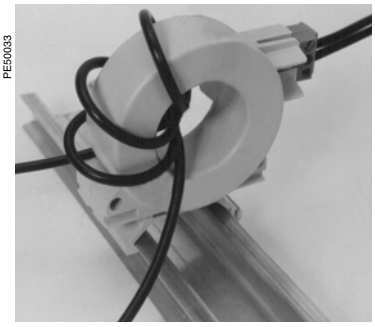
Connection

The CSH30 is adapted for the type of current transformer, 1 A or 5 A, by the number of turns of the secondary wiring through the CSH30 interposing ring CT:

- 5 A rating: 4 turns
- 1 A rating: 2 turns

Connection to 5 A secondary circuit

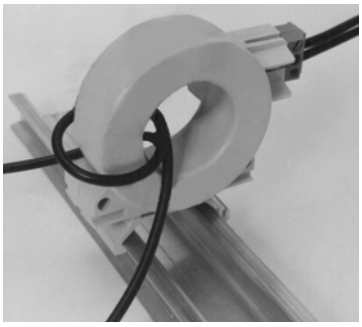
PE50033



1. Plug into the connector.
2. Insert the transformer secondary wire through the CSH30 interposing ring CT 4 times.

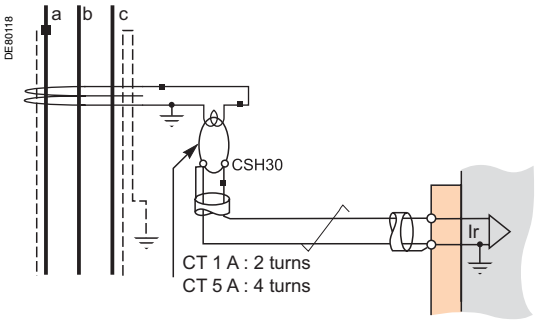
Connection to 1 A secondary circuit

PE50034



1. Plug into the connector.
2. Insert the transformer secondary wire through the CSH30 interposing ring CT twice.

DE80118



Connection to Sepam™ Series 20 and Sepam Series 40

- To residual current Ir input, on connector (A), terminals 19 and 18 (shielding)

Connection to Sepam Series 80

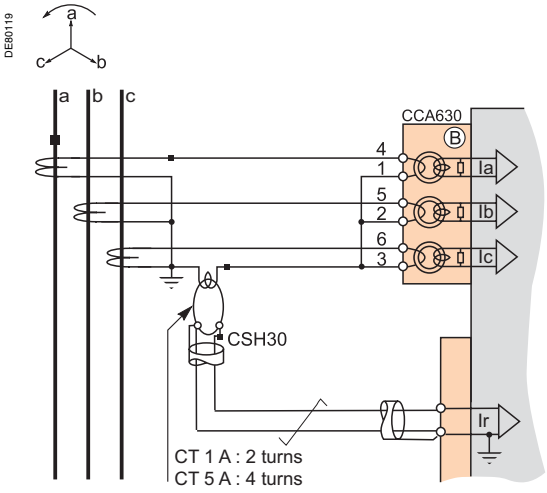
- To residual current Ir input, on connector (E), terminals 15 and 14 (shielding)
- To residual current I'r input, on connector (E), terminals 18 and 17 (shielding)

Recommended Cable

- Sheathed cable, shielded by tinned copper braid
- Minimum cable cross-section 0.0014 in² (0.93 mm²), AWG 18
  - Max. 0.0039 in² (2.5 mm²), AWG 12
- Resistance per unit length < 100 mΩ/m (30.5 mΩ/ft)
- Minimum dielectric strength: 1000 V (700 Vrms)
- Maximum length: 6.6 ft (2 m).

The CSH30 interposing ring CT must be installed near the Sepam relay — the CSH30 link cable is less than 6.6 ft (2 m) long. Also, flatten the connection cable against the metal frames of the cubicle. The connection cable shielding is grounded in the Sepam relay; do not ground the cable by any other means.

DE80119



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ACE990 Zero Sequence CT Interface

PE50037

ACE990 Zero Sequence CT Interface

Function

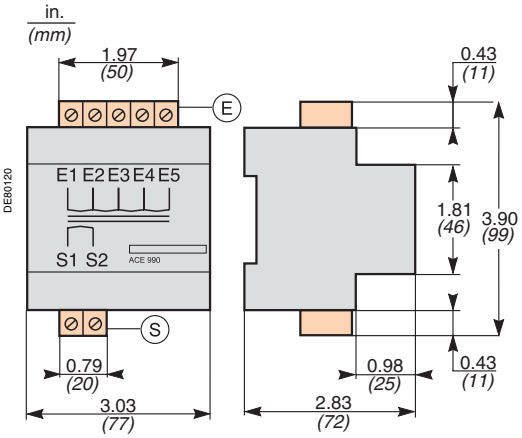
The ACE990 is used to adapt measurements between an MV zero sequence CT with a ratio of 1/n (50 ⩽ n ⩽ 1500), and the Sepam™ residual current input.

Characteristics

Weight	1.41 lb (0.64 kg)
Assembly	Mounted on Symmetrical DIN rail
Amplitude Accuracy	±1%
Phase Accuracy	< 2°
Maximum Permissible Current	20 kA - 1 s (On the primary winding of an MV zero sequence CT with a ratio of 1/50 that does not saturate)
Operating Temperature	23° to 131° F (-5° to +55° C)
Storage Temperature	-13° to +158° F (-25° to +70° C)

Description and Dimensions

DE80120



(E) ACE990 input terminal block, for connection of the zero sequence CT.

(S) ACE990 output terminal block, for connection of the Sepam relay residual current.

6

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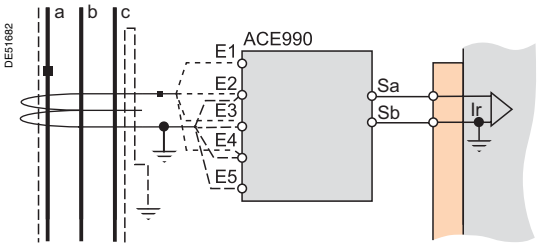
ACE990 Zero Sequence CT Interface



Connection

Connection of Zero Sequence CT

Only one zero sequence CT can be connected to the ACE990 interface. The secondary circuit of the MV zero sequence CT is connected to 2 of the 5 ACE990 interface input terminals. To define the 2 input terminals, it is necessary to know the following:

- Zero sequence CT ratio (1/n)
- Zero sequence CT power
- Close approximation of rated current INr
  - INr is a general setting in Sepam™ and defines the ground fault protection setting range between 0.1 INr and 15 INr

The table below can be used to determine:

- The 2 ACE990 input terminals to be connected to the MV zero sequence CT secondary
- The type of residual current sensor to set
- The exact value of the rated residual current INr setting
  - Defined by the following formula: **INr = k x number of zero sequence CT turns**
  - k factor defined in the table below

The zero sequence CT must be connected to the interface in the right direction for correct operation: the MV zero sequence CT secondary output terminal S1 must be connected to the terminal with the lowest index (Ex).

K Value	ACE990 Input Terminals to be Connected	Residual Current Sensor Setting	Min. MV Zero Sequence CT Power
0.00578	E1 - E5	ACE990 - Range 1	0.1 VA
0.00676	E2 - E5	ACE990 - Range 1	0.1 VA
0.00885	E1 - E4	ACE990 - Range 1	0.1 VA
0.00909	E3 - E5	ACE990 - Range 1	0.1 VA
0.01136	**E2 - E4**	**ACE990 - Range 1**	**0.1 VA**
0.01587	E1 - E3	ACE990 - Range 1	0.1 VA
0.01667	E4 - E5	ACE990 - Range 1	0.1 VA
0.02000	E3 - E4	ACE990 - Range 1	0.1 VA
0.02632	E2 - E3	ACE990 - Range 1	0.1 VA
0.04000	E1 - E2	ACE990 - Range 1	0.2 VA
0.05780	E1 - E5	ACE990 - Range 2	2.5 VA
0.06757	E2 - E5	ACE990 - Range 2	2.5 VA
0.08850	E1 - E4	ACE990 - Range 2	3.0 VA
0.09091	E3 - E5	ACE990 - Range 2	3.0 VA
0.11364	E2 - E4	ACE990 - Range 2	3.0 VA
0.15873	E1 - E3	ACE990 - Range 2	4.5 VA
0.16667	E4 - E5	ACE990 - Range 2	4.5 VA
0.20000	E3 - E4	ACE990 - Range 2	5.5 VA
0.26316	E2 - E3	ACE990 - Range 2	7.5 VA

Example:

Given a zero sequence CT with a ratio of 1/400 2 VA, used within a measurement range of 0.5–60 A.

How should it be connected to Sepam via the ACE990?

1. *Choose a close approximation of the rated current INr, i.e. 5 A.*
2. *Calculate the ratio:*
   approx. INr/number of turns = 5/400 = 0.0125.
3. *Find the closest value of k in the table opposite to k = 0.01136.*
4. *Check the mininum power required for the zero sequence CT:*
   2 VA zero sequence CT > 0.1 VA V OK.
5. *Connect the zero sequence CT secondary to ACE990 input terminals E2 and E4.*
6. *Set Sepam up with:*
   INr = 0.01136 x 400 = 4.5 A.

This value of INr can be used to monitor current between 0.45 A and 67.5 A.

Wiring of MV zero sequence CT secondary circuit:

- *MV zero sequence CT S1 output to ACE990 E2 input terminal*
- *MV zero sequence CT S2 output to ACE990 E4 input terminal.*

Connection to Sepam™ Series 20 and Sepam Series 40

To residual current Ir input, on connector (A), terminals 19 and 18 (shielding).

Connection to Sepam Series 80

- To residual current Ir input, on connector (E), terminals 15 and 14 (shielding)
- To residual current I'r input, on connector (E), terminals 18 and 17 (shielding).

Recommended Cables

- Cable between zero sequence CT and ACE990: less than 160 ft (50 m) long
- Sheathed cable, shielded by tinned copper braid between the ACE990 and Sepam, maximum length 6.6 ft (2 m)
- Cable cross-section between 0.93 mm² (AWG 18) and 2.5 mm² (AWG 12)
- Resistance per unit length less than 30.5 mΩ /ft (100 mΩ /m)
- Minimum dielectric strength: 100 Vrms

Connect the connection cable shielding in the shortest manner possible, 2 in (5.08 cm) maximum, to the shielding terminal on the Sepam connector. Flatten the connection cable against the metal frames of the cubicle.

The connection cable shielding is grounded in the Sepam relay. Do not ground the cable by any other means.

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⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

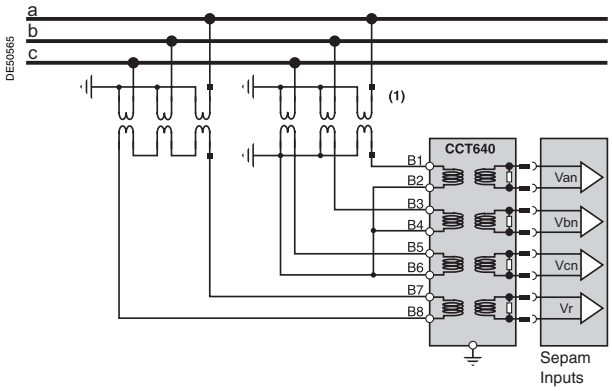
- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

Failure to follow these instructions will result in death or serious injury.

The phase and residual voltage transformer secondary circuits are connected to the CCT640 connector, item Ⓑ on B2X type Sepam™ units.

CCT640 Connector

The connector contains 4 transformers which provide impedance matching and isolation between the VTs and Sepam input circuits.
Terminals B1 to B6 are intended for phase voltage measurement (1), and B7 and B8 for residual voltage measurement (case shown, not connected if obtained by the sum of the 3 phase voltages).



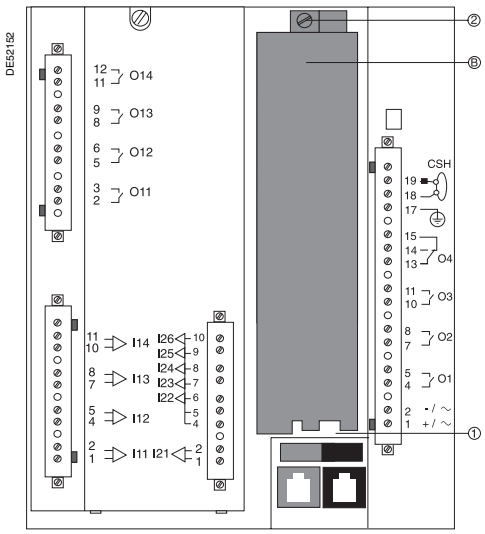
(1) *1, 2, or 3 VTs (case shown).*

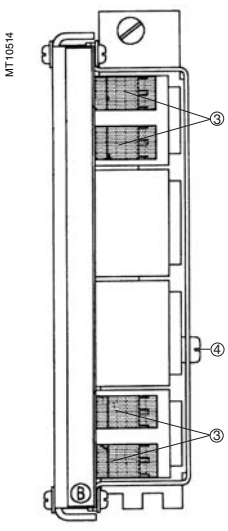
Installation of the CCT640 Connector

1. Insert the connector pins into the slots ① on the base unit.
2. Flatten the connector against the unit to plug it into the 9-pin SUB-D connector (principle similar to that of the MES module).
3. Tighten the mounting screw ②.

Connection

- The connections are made to the screw type connectors that can be accessed on the rear of the CCT640 (item ③)
- Wiring with no fittings:
  - 1 wire with maximum cross-section of 0.00003–0.0039 in² (0.2–2.5 mm²), AWG 24-12
  - 2 wires with maximum cross-section of 0.00003–0.0016 in² (0.2–1 mm²), AWG 24-18
  - Stripped length: 0.315–0.39 in (8–10 mm)
- Wiring with fittings:
  - Recommended wiring with Telemecanique fitting:
    - DZ5CE015D for 1 wire 0.0023 in² (1.5 mm²), AWG 16
    - DZ5CE025D for 1 wire 0.0039 in² (2.5 mm²), AWG 12
    - AZ5DE010D for 2 wires 0.0016 in² (1 mm²), AWG 18
  - Cable length: 0.32 in (8.2 mm)
  - Stripped length: 0.31 in (8 mm)
- The CCT640 must be grounded (by green/yellow wire + ring lug) on the screw ④
  - Safety measure in case the CCT640 becomes unplugged





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MES114 Module I/O
10 Inputs & 4 Outputs

PE50476

10 input/4 output MES114 module

Function

The 4 outputs included on the Sepam™ Series 20 and 40 base unit. This can be extended by adding an optional MES114 module with 10 inputs and 4 outputs, available in 3 versions:

- MES114: 10 inputs & 4 outputs, voltage 24–250 V DC
- MES114E: 10 inputs & 4 outputs, voltage 110–125 V AC or V DC
- MES114F: 10 inputs & 4 outputs, voltage 220–250 V AC or V DC

Characteristics

MES114 Module					
Weight	0.617 lb (0.28 kg)				
Operating Temperature	-13° to +158°F (-25° to +70° C)				
Environmental Characteristics	Same characteristics as Sepam base units				

Logic Inputs	**MES114**	**MES114E**		**MES114F**	
Voltage	24–250 V DC	110–125 V DC	110 V AC	220–250 V DC	220–240 V AC
Range	19.2–275 V DC	88–150 V DC	88–132 V AC	176–275 V DC	176–264 V AC
Frequency	—	—	47–63 Hz	—	47–63 Hz
Typical Consumption	3 mA	3 mA	3 mA	3 mA	3 mA
Typical Switching Threshold	14 V DC	82 V DC	58 V AC	154 V DC	120 V AC
Input Limit Voltage State 1	⩾ 19 V DC	⩾ 88 V DC	⩾ 88 V AC	⩾ 176 V DC	⩾ 176 V AC
Input Limit Voltage State 0	⩽ 6 V DC	⩽ 75 V DC	⩽ 22 V AC	⩽ 137 V DC	⩽ 48 V AC
Isolation of Inputs from Other Isolated Groups	Enhanced	Enhanced	Enhanced	Enhanced	Enhanced

O11 Control Relay Output (1)					
Voltage	DC	24/48 V DC	127 V DC	250 V DC Typical	
	AC (47.5–63 Hz)				100–240 V AC
Continuous Current		8 A	8 A	8 A	8 A
Breaking Capacity	Resistive Load	8/4 A	0.7 A	0.3 A	8 A
	L/R Load < 20 ms	6/2 A	0.5 A	0.2 A	
	L/R Load < 40 ms	4/1 A	0.2 A	0.1 A	
	p.f. load > 0.3				5 A
Making Capacity		< 15 A for 200 ms			
Isolation of Outputs from Other Isolated Groups	Enhanced				

Annunciation Relay Output O12 to O14					
Voltage	DC	24/48 V DC	127 V DC	250 V DC Typical	
	AC (47.5–63 Hz)				100–240 V AC
Continuous Current		2 A	2 A	2 A	2 A
Breaking Capacity	L/R load < 20 ms	2/1 A	0.5 A	0.15 A	
	p.f. load > 0.3				1 A
Making Capacity		< 15 A for 200 ms			
Isolation of Outputs in Relation to Other isolated Groups	Enhanced				

(1) *Complies with clause 6.7 of standard C37.90 (30A, 200ms, 2000 operations).*
See "Technical Characteristics" table at the beginning of this manual.

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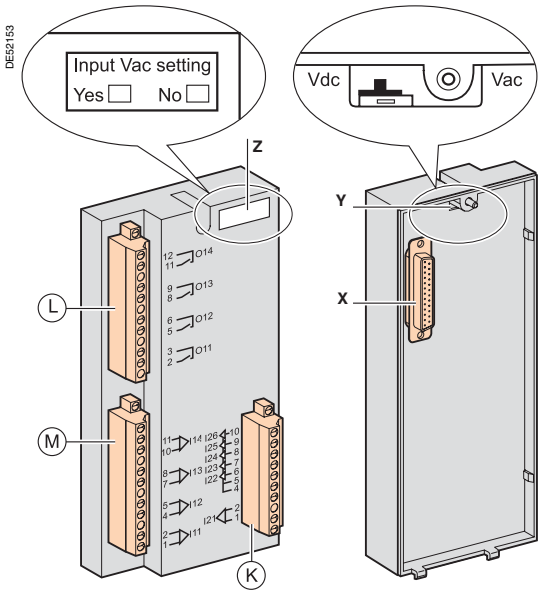
MES114 Module I/O
10 Inputs & 4 Outputs



Description

Ⓛ, Ⓜ and Ⓚ : 3 removable, lockable screw-type connectors

Ⓛ : Connectors for 4 relay outputs:
- O11: 1 control relay output
- O12 to O14: 3 annunciation relay outputs

Ⓜ : Connectors for 4 independent logic inputs I11 to I14

Ⓚ : Connectors for 6 logic inputs:
- I21: 1 independent logic input
- I22 to I26: 5 common point logic inputs

Also, in the diagram to the left:
X 25-pin sub-D connector to connect the module to the base unit.
Y Voltage selector switch for MES114E and MES114F module inputs, to be set to:
- V DC for DC voltage inputs (default setting)
- V AC for AC voltage inputs

Z Label to be filled in to indicate the chosen parameter setting for MES114E and MES114F input voltages.

The parameter setting status can be accessed in the **Sepam™ Diagnosis** screen of the SFT2841 software tool. Parameter setting of the inputs for AC voltage (V AC setting) blocks the "Operating Time Measurement" function.

Assembly

Refer to the photo to the left:
1. Insert the 2 pins on the MES module into the slots (**1)** on the base unit.
2. Flatten the module up against the base unit to plug it into the connector (**2**).
3. Tighten the mounting screw **(3**).

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Connection

The inputs are potential-free and the DC power supply source is external.

⚠ DANGER

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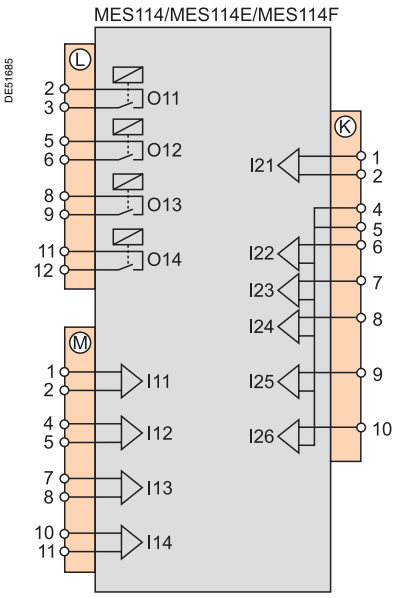
- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Screw tight all terminals, even those not in use.

Failure to follow these instructions will result in death or serious injury.



Wiring of connectors Ⓛ, Ⓜ and Ⓚ :

- Wiring with no fittings:
  - 1 wire with maximum cross-section of 0.00003–0.0039 in^2 (0.2–2.5 mm^2) (AWG 24-12)
  - 2 wires with maximum cross-section of 0.00003–0.0016 in^2 (0.2–1 mm^2) (AWG 24-18)
  - Stripped length: 0.315 to 0.39 in (8–10 mm)
- Wiring with fittings:
  - Terminal 5, recommended wiring with Telemecanique fitting:
    - DZ5CE015D for 1 wire 0.0023 in^2 (1.5 mm^2) (AWG 16)
    - DZ5CE025D for 1 wire 0.0039 in^2 (2.5 mm^2) (AWG 12)
    - AZ5DE010D for 2 wires 0.0016 in^2 (1 mm^2) (AWG 18)
  - Cable length: 0.32 in (8.2 mm)
  - Stripped length: 0.31 in (8 mm)

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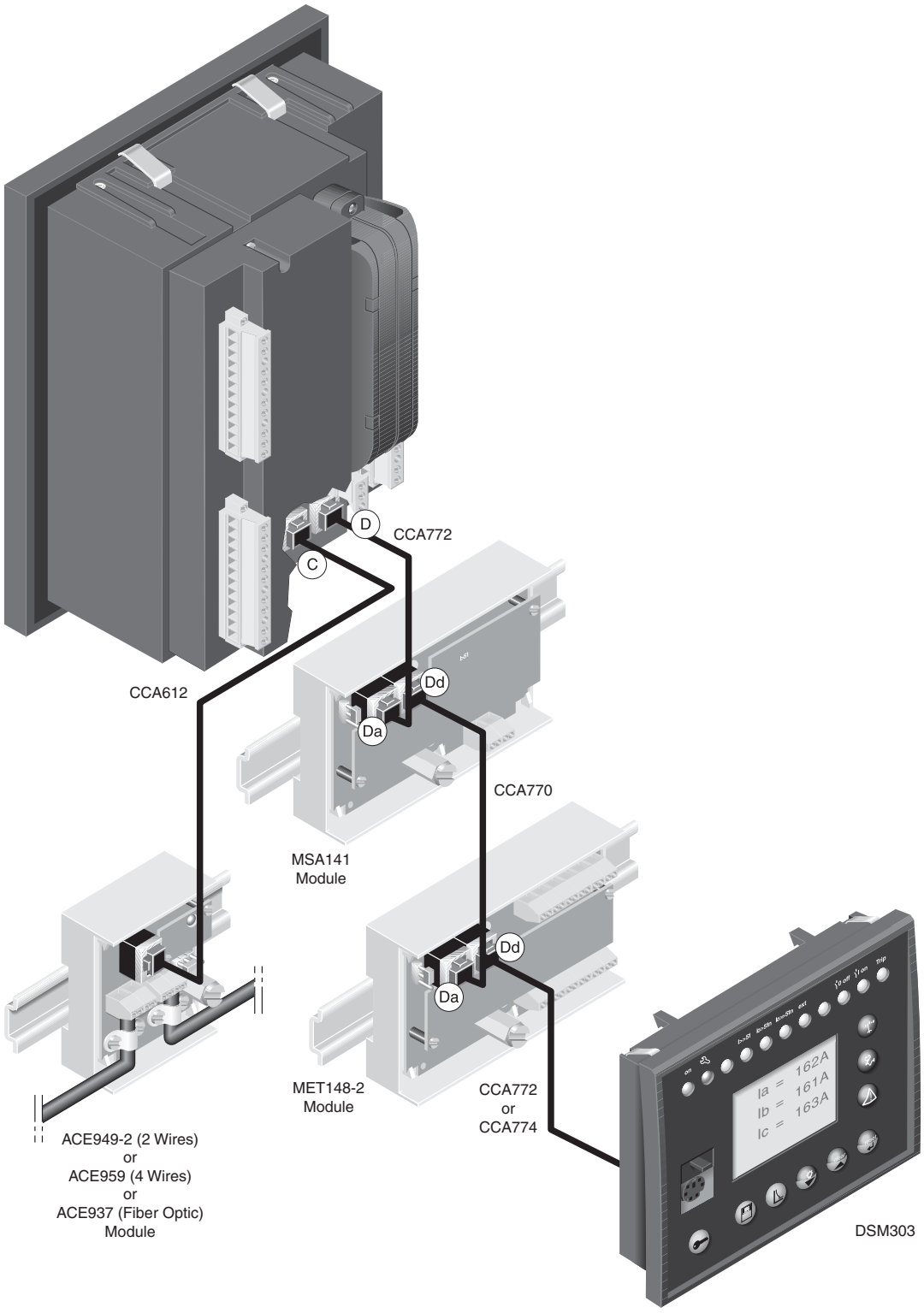
Optional Remote Modules
MET1482, MSA141, or DSM303 Connection

The optional MET1482, MSA141 or DSM303 modules are connected to the base unit connector Ⓓ by a series of links using prefabricated cords which come in 3 different lengths with black fittings.

- CCA770 (L = 2 ft or 0.6 m)
- CCA772 (L = 6.6 ft or 2 m)
- CCA774 (L = 13.1 ft or 4 m)

The DSM303 module can only be connected at the end of the series. The MSA141 module must be the first one connected to the Sepam™ unit. The diagram below shows the maximum configuration with 3 optional modules.

DE50566



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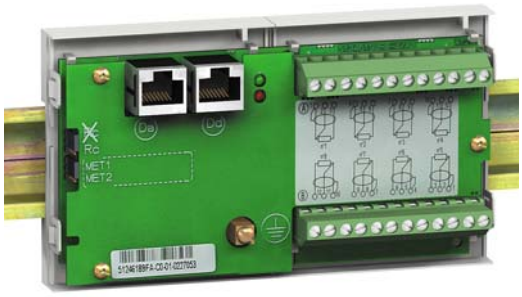
MET1482
Temperature Sensor Module

PE50021



Function

The MET1482 module can be used to connect 8 temperature sensors (RTDs) of the same type:

- Pt100, Ni100 or Ni120 type RTDs, according to parameter setting
- 3-wire temperature sensors
- A single module for each Sepam™ Series 20 base unit, to be connected by one of the CCA770 2 ft (0.6 m), CCA772 6.6 ft (2 m), or CCA774 13.1 ft (4 m) cords
- 2 modules for each Sepam Series 40 or Series 80 base unit, to be connected by CCA770 2 ft (0.6 m), CCA772 6.6 ft (2 m), or CCA774 13.1 ft (4 m) cords

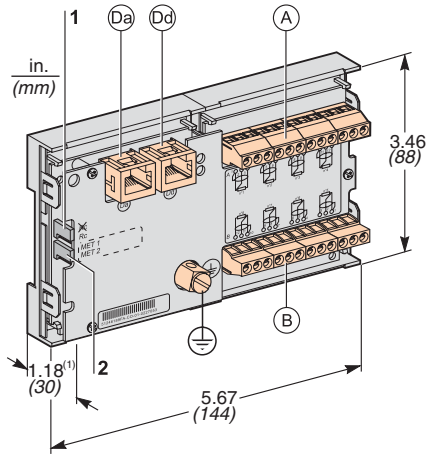
The temperature measurement (e.g. in a transformer or motor winding) is utilized by the following protection functions:

- Thermal overload (to take ambient temperature into account)
- Temperature monitoring

Characteristics

MET1482 Module		
Weight	0.441 lb (0.2 kg)	
Assembly	On symmetrical DIN rail	
Operating Temperature	-13° to +158° F (-25° to +70° C)	
Environmental Characteristics	Same Characteristics as Sepam Base Units	
Temperature Sensors	**Pt100**	**Ni100/Ni120**
Isolation from Ground	None	None
Current Injected in RTD	4 mA	4 mA

DE80121



(1) *70 mm (2.8 in) with CCA77x Cord Connected*

Description and Dimensions

(A) Terminal block for RTDs 1–4
(B) Terminal block for RTDs 5–8
(Da) RJ45 connector to connect the module to the base unit with a CCA77x cord
(Dd) RJ45 connector to link up the next remote module with a CCA77x cord (according to application)
(⏚) Grounding terminal

1 Jumper for impedance matching with load resistor (Rc), to be set to:
- ~~Rc~~, if the module is not the last interlinked module (default position)
- Rc, if the module is the last interlinked module.

2 Jumper used to select module number, to be set to:
- MET1: 1st MET1482 module, to measure temperatures T1 to T8 (default position)
- MET2: 2nd MET1482 module, to measure temperatures T9 to T16 (for Sepam Series 40 and Series 80 only)

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MET1482
Temperature Sensor Module

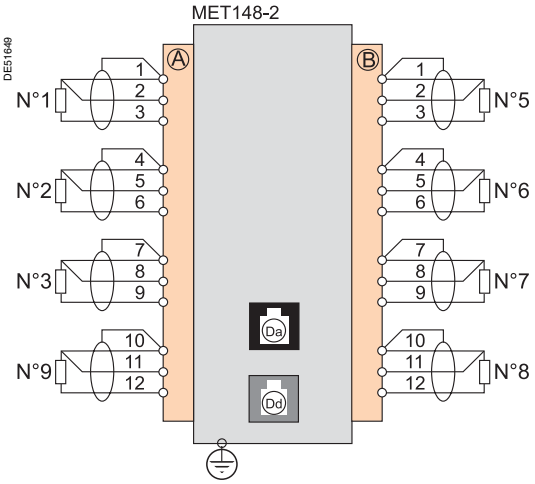
Connection

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Check that the temperature sensors are isolated from dangerous voltages.

Failure to follow these instructions will result in death or serious injury.



Connection of the Grounding Terminal

By tinned copper braid with cross-section ⩾ 0.0093 in² (6 mm²)(AWG 10) or cable with cross-section ⩾ 0.0039 in² (2.5 mm²) (AWG 12) and length ⩽ 7.9 in (200 mm), fitted with a 0.16 in (4 mm) ring lug. Check the tightness (maximum tightening torque 2.2 Nm or 19.5 lb-in).

Connection of RTDs to Screw-Type Connectors

- 1 wire with cross-section 0.00003–0.0039 in² (0.2–2.5 mm²) (AWG 24-12)
- 2 wires with cross-section 0.00003–0.0016 in² (0.2–1 mm²) (AWG 24-18)

Recommended cross-sections according to distance:

- Up to 330 ft (100 m) ⩾ 0.0016 in² (1 mm²) (AWG 18)
- Up to 990 ft (300) ⩾ 0.0023 in² (1.5 mm²) (AWG 16)
- Up to 0.62 mi (1 km) ⩾ (2.5 mm²) (AWG 12)

Maximum distance between sensor and module: 1 km (0.62 mi)

Wiring Precautions

- Shielded cables are preferable
  - The use of unshielded cables can cause measurement errors which vary in degree according to the level of surrounding electromagnetic disturbance
- Only connect the shielding at the MET1482 end, in the shortest manner possible, to the corresponding terminals of connectors Ⓐ and Ⓑ
- Do not connect the shielding at the RTD end

Accuracy Derating According to Wiring

The error Δt is proportional to the length of the cable and inversely proportional to the cable cross-section:

$$\Delta t(°C) = 2 \times \frac{L(km)}{S(mm^2)}$$

- ±2.1°C/km for 0.93 mm² cross-section (AWG 18)
- ±1°C/km for 1.92 mm² cross-section (AWG 14)

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MSA141
Analog Output Module

M111009

MSA141 Analog Output Module

Function

The MSA141 module converts one of the Sepam™ measurements into an analog signal:

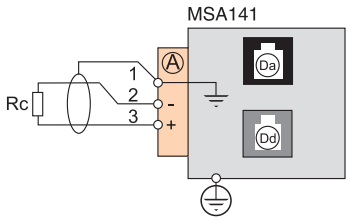
- Selection of the measurement to be converted by parameter setting
- 0-10 mA, 4-20 mA, 0-20 mA analog signal according to parameter setting
- Scaling of the analog signal by setting minimum and maximum values of the converted measurement
  - E.g., the setting used to have phase current 1 as a 0–10 mA analog output with a dynamic range of 0–300 A is:
    - Minimum value = 0
    - Maximum value = 3000
- A single module for each Sepam base unit, to be connected by one of the CCA770 2 ft (0.6m), CCA772 6.6 ft (2m) or CCA774 13.1 ft (4m) cords

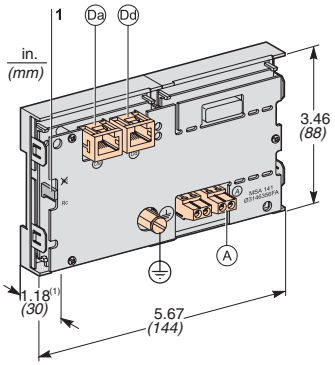
The analog output can also be remotely managed via the communication network.

Characteristics

MSA141 Module	
Weight	0.441 lb (0.2 kg)
Assembly	On symmetrical DIN rail
Operating Temperature	-13° to +158° F (-25° to +70° C)
Environmental Characteristics	Same Characteristics as Sepam Base Units
Analog Output	
Current	4 -20 mA, 0-20 mA, 0-10 mA
Scaling (No Data Input Checking)	Minimum Value
	Maximum Value
Load Impedance	< 600 Ω (Including Wiring)
Accuracy	0.5%

Measurements Available	Unit	Series 20	Series 40	Series 80
Phase and Residual Currents	0.1 A	■	■	■
Phase-to-Neutral and phase-to-Phase Voltages	1 V	■	■	■
Frequency	0.01 Hz	■	■	■
Thermal Capacity Used	1%	■	■	■
Temperatures	1° F (1° C)	■	■	■
Active Power	0.1 kW		■	■
Reactive Power	0.1 kvar		■	■
Apparent Power	0.1 kVA		■	■
Power Factor	0.01			■
Remote Setting via Communication Link		■	■	■





DE80122

(1) *70 mm (2.8 in) with CCA77x Cord Connected*

Description and Dimensions

(A) Terminal block for analog output

(Da) RJ45 socket to connect the module to the base unit with a CCA77x cord

(Dd) RJ45 socket to link up the next remote module with a CCA77x cord (according to application)

(⏚) Grounding terminal

1 Jumper for impedance matching with load resistor (Rc), to be set to:
- ■ ~~Rc~~, if the module is not the last interlinked module (default position)
- ■ Rc, if the module is the last interlinked module

Connection

Connection of the Grounding Terminal

By tinned copper braid with cross-section ⩾ 0.0093 in² (6 mm²) (AWG 10) or cable with cross-section ⩾ 0.0039 in² (2.5 mm²) (AWG 12) and length ⩽ 7.9 in (200 mm), equipped with a 0.16 in (4 mm) ring lug. Check the tightness (maximum tightening torque 2.2 Nm or 19.5 lb-in).

Connection of Analog Output to Screw-Type Connector

- 1 wire with cross-section 0.00003–0.0039 in² (0.2–2.5 mm²) (AWG 24-12)
- 2 wires with cross-section 0.00003–0.0016 in² (0.2–1 mm²) (AWG 24-18)

Wiring Precautions

- Shielded cables are preferable
- Use tinned copper braid to connect the shielding at least at the MSA141 end

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment, after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Check that the temperature sensors are isolated from dangerous voltages.

Failure to follow these instructions will result in death or serious injury.

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DSM303
Remote Advanced UMI Module

PE50127

DSM303 remote advanced UMI module

Function

When associated with a Sepam™ relay that does not have its own advanced user-machine interface, the DSM303 offers all the functions available on a Sepam integrated advanced UMI.

The DSM303 can be installed on the front panel of the cubicle in the most suitable operating location:
- Reduced depth < 1.2 in (30 mm)
- A single module for each Sepam, to be connected by one of the CCA772 6.6 ft (2 m) or CCA774 13.1 ft (4 m) cords

The module cannot be connected to Sepam units with integrated advanced UMIs.

Characteristics

DSM303 Module	
Weight	0.661 lb (0.3 kg)
Assembly	Flush-Mounted
Operating Temperature	-13° to +158° F (-25° to +70° C)
Environmental Characteristics	Same Characteristics as Sepam Base Units

6

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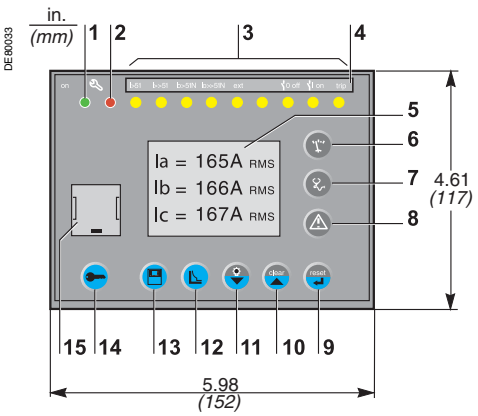
DSM303
Remote Advanced UMI Module

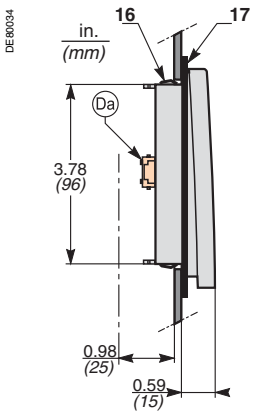
Description and Dimensions

The module is simply flush-mounted and secured by its clips. No additional screw-type fastening is required.

Front view



Side view



1 Green LED: Sepam™ on
2 Red LED:
- Steadily on: module unavailable
- Flashing: Sepam link unavailable

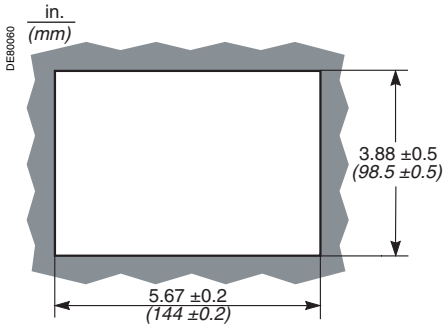
3 9 yellow LEDs
4 Label identifying the LEDs
5 Graphic LCD screen
6 Display of measurements
7 Display of switchgear, network and machine diagnosis data
8 Display of alarm messages
9 Sepam reset (or confirm data entry)
10 Alarm acknowledgment and clearing (or move cursor up)
11 LED test (or move cursor down)
12 Access to protection settings
13 Access to Sepam parameters
14 Entry of 2 passwords
15 PC connection port
16 Mounting clip
17 Gasket to ensure NEMA 12 tightness
(gasket supplied with the DSM303 module, to be installed if necessary)

(Da) RJ45 lateral output connector to connect the module to the base unit with a CCA77x cord.

⚠ CAUTION

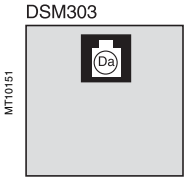
HAZARD OF CUTS
Trim the edges of the cut-out plates to remove any jagged edges.
Failure to follow this instruction can cause serious injury.

Cut-out for Flush-Mounting (Mounting Plate Thickness < 0.12 in or 3 mm)



Connection

(Da) RJ45 socket to connect the module to the base unit with a CCA77x cord. The DSM303 module is always the last interlinked remote module and it systematically ensures impedance matching by load resistor (Rc).



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Communication Accessories Selection Guide

There are 2 types of Sepam™ relay communication accessories:
- Communication interfaces, which are essential for connecting Sepam to the communication network
- Converters and other accessories, as options, which are used for complete implementation of the communication network

Communication-Interface Selection Guide

		ACE9492	ACE959	ACE937	ACE969TP		ACE969FO	
Type of Network								
		S-LAN or E-LAN (1)	S-LAN or E-LAN (1)	S-LAN or E-LAN (1)	S-LAN	E-LAN	S-LAN	E-LAN
Protocol								
Modbus		■	■	■	■	■	■	■
DNP3					■		■	
IEC 60870-5-103					■		■	
Physical Interface								
RS485	2-Wire	■			■	■		■
	4-Wire		■					
Fiber Optic ST	Star			■			■	
	Ring						■(2)	
See Details on Page		**158**	**159**	**160**	**161**		**161**	

(1) *Only one connection possible, S-LAN or E-LAN.*
(2) *Except with the Modbus protocol.*

Converter Selection Guide

	ACE9092	ACE919CA	ACE919CC	EGX100	EGX400
Converter					
Port to Supervisor	1 RS232 Port	1 2-wire RS485 Port	1 2-wire RS485 Port	1 Ethernet Port 10T/100Tx Auto	1 Ethernet Port 10/100 Base Tx and 1 Ethernet Port 100 Base FX
Port to Sepam	1 2-Wire RS485 Port	1 2-Wire RS485 Port	1 2-Wire RS485 Port	1 2-wire RS485 or 4-wire RS485 Port	2 2-Wire RS485 or 4-Wire RS485 Ports
Distributed Power Supply RS485	Supplied by ACE	Supplied by ACE	Supplied by ACE	Not Supplied by EGX	Not Supplied by EGX
Protocol					
Modbus	■	■	■	■	■
IEC 60870-5-103	■	■	■		
DNP3	■	■	■		
Power Supply					
DC			24–48 V DC	24 V DC	24 V DC
AC	110–220 V AC	110–220 V AC			100–240 V AC (with Adapter)
See Details on Page	**166**	**168**	**168**	**See EGX100 Manual**	**See EGX400 Manual**

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Communication Interface Connection

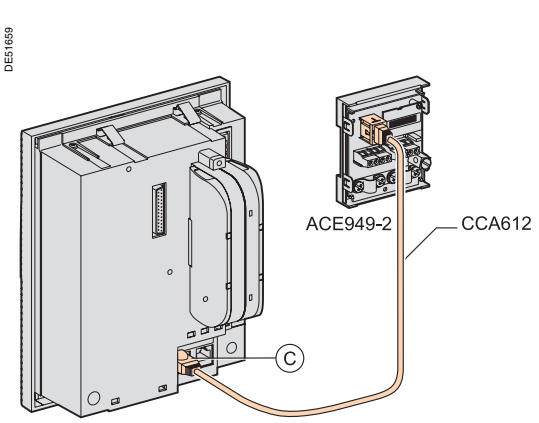
CCA612 Connection Cord

Plugging into a Sepam™ Relay

Cord used to connect a communication interface to a Sepam base unit:

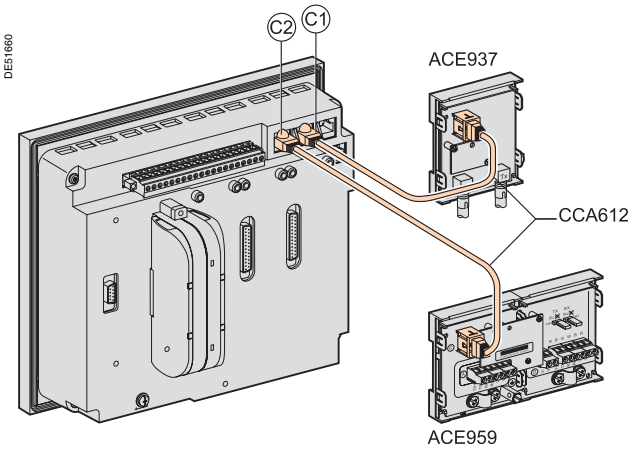
- Length = 9.8 ft (3 m)
- Fitted with 2 green RJ45 plugs

Sepam Series 20 and Sepam Series 40



Sepam Series 20 and Sepam Series 40: 1 Communication Port

Sepam Series 80



Sepam Series 80: 2 Communication Ports

Connection to the Communication Network

RS485 Network Cable	2-Wire	4-Wire
RS485 Medium	1 Shielded Twisted Pair	2 Shielded Twisted Pairs
Distributed Power Supply	1 Shielded Twisted Pair	1 Shielded Twisted Pair
Shielding	Tinned copper braid, coverage > 65%	
Characteristic Impedance	120 Ω	
Gauge	AWG 24	
Resistance per unit Length	< 62.1 Ω /mi (100 Ω /km)	
Capacitance Between Conductors	< 18.3 pF/ft (60 pF/m)	
Capacitance Between Conductor and Shielding	< 30.5 pF/ft (100 pF/m)	
Maximum Length	4270 ft (1300 m)	

Fiber Optic				
Fiber Type	Graded-Index Multimode Silica			
Wavelength	820 nm (Invisible Infrared)			
Type of Connector	ST (BFOC Bayonet Fiber Optic Connector)			
Fiber Optic Diameter (µm)	**Numerical Aperture (NA)**	**Maximum Attenuation (dBm/km)**	**Minimum Optical Power Available (dBm)**	**Maximum Fiber Length**
50/125	0.2	2.7	5.6	2300 ft (700 m)
62.5/125	0.275	3.2	9.4	5900 ft (1800 m)
100/140	0.3	4	14.9	9200 ft (2800 m)
200 (HCS)	0.37	6	19.2	8500 ft (2600 m)

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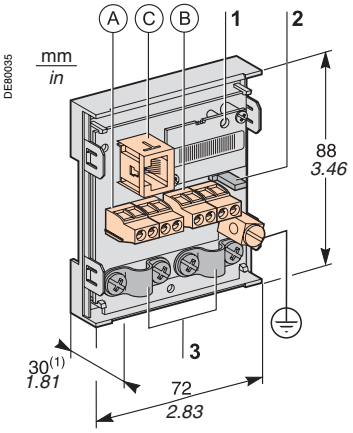
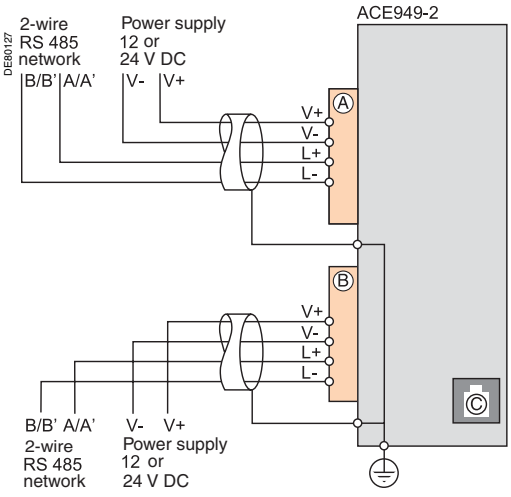
ACE9492
2-wire RS485 Network Interface

ACE9492 2-Wire RS485 Network Connection Interface



(1) *70 mm (2.8 in) with CCA612 Cord Connected*



Note: *The shield connection should be grounded at only one end of the serial daisy chain.*

Function

The ACE9492 interface performs 2 functions:

- Electrical interface between the Sepam™ relay and a 2-wire RS485 communication network
- Main network cable branching box for the connection of a Sepam with a CCA612 cord

Characteristics

ACE9492 Module	
Weight	0.22 lb (0.1 kg)
Assembly	On symmetrical DIN rail
Operating Temperature	-13° to +158° F (-25° to +70° C)
Environmental Characteristics	Same Characteristics as Sepam Base Units

2-wire RS485 Electrical Interface	
Standard	EIA 2-Wire RS485 Differential
Distributed Power Supply	External, 12 V DC or 24 V DC ±10%
Power Consumption	16 mA in Receiving Mode
	40 mA Maximum in Sending Mode

Maximum Length of 2-Wire RS485 Network with Standard Cable

Number of Sepam Relay Units	Maximum Length with 12 V DC Power Supply	Maximum Length with 24 V DC Power Supply
5	1000 ft (320 m)	3300 ft (1000 m)
10	590 ft (180 m)	2500 ft (750 m)
20	520 ft (160 m)	1500 ft (450 m)
25	410 ft (125 m)	1200 ft (375 m)

Description and Dimensions

(A) and (B) Terminal blocks for network cable

(C) RJ45 socket to connect the interface to the base unit with a CCA612 cord

(t) Grounding terminal

1 Link activity LED, flashes when communication is active (sending or receiving in progress).

2 Jumper for RS485 network line-end impedance matching with load resistor (Rc = 150 Ω), to be set to:
- ~~Rc~~, if the module is not at one end of the network (default position)
- Rc, if the module is at one end of the network

3 Network cable clamps (inner diameter of clamp = 0.24 in or 6 mm).

Connection

- Connection of network cable to screw-type terminal blocks (A) and (B)
- Connection of the grounding terminal by:
  - Tinned copper braid with cross-section ⩾ 0.0093 in² (6 mm²), AWG 10
  - Cable with cross-section ⩾ 0.0039 in² (2.5 mm²), AWG 12
    - Length ⩽ 7.9 in (200 mm), fitted with a 0.16 in (4 mm) ring lug
    - Check the tightness (maximum tightening torque 2.2 Nm or 19.5 lb-in)
- The interfaces are fitted with clamps to hold the network cable and recover shielding at the incoming and outgoing points of the network cable:
  - The network cable must be stripped
  - The cable shielding braid must be around and in contact with the clamp
- The interface is to be connected to connector (C) on the base unit using a 9.8 ft (3 m) CCA612 cord (green fittings)
- The interfaces are to be supplied with 12 V DC or 24 V DC

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment, after reading this entire set of instructions and checking the characteristics of the device.
- NEVER work alone.
- Check that the temperature sensors are isolated from dangerous voltages.

Failure to follow these instructions will result in death or serious injury.

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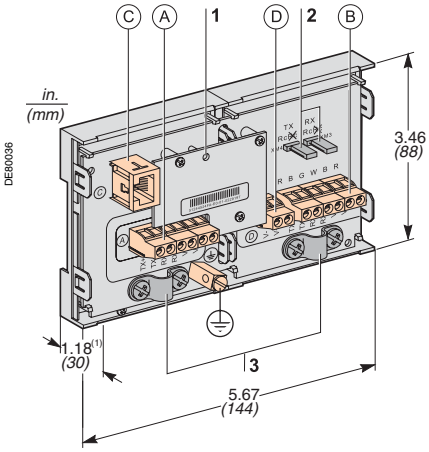
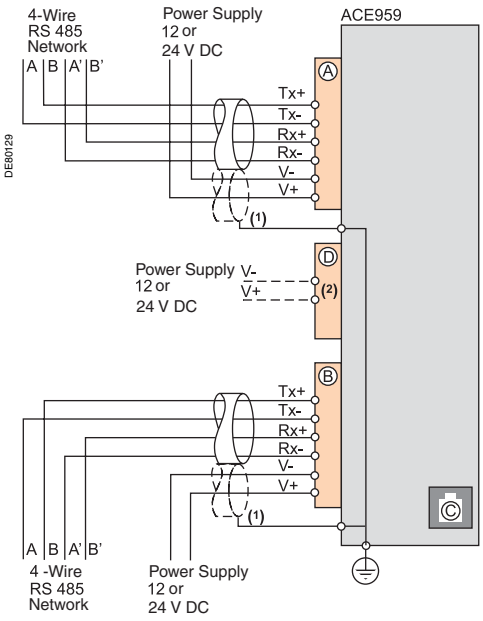
ACE959
4-wire RS485 Network Interface

ACE959 4-Wire RS485 Network Connection Interface



(1) *70 mm (2.8 in) with CCA612 Cord Connected*



(1) *Distributed power supply with separate wiring or included in the shielded cable (3 pairs).*

(2) *Terminal block for connection of the distributed power supply module.*

Note: *The shield connection should be grounded at only one end of the serial daisy chain.*

Function

The ACE959 interface performs 2 functions:

- Electrical interface between the Sepam™ relay and a 4-wire RS485 communication network
- Main network cable branching box for the connection of a Sepam with a CCA612 cord

Characteristics

ACE959 Module	
Weight	0.441 lb (0.2 kg)
Assembly	On symmetrical DIN rail
Operating Temperature	-13° to +158° F (-25° to +70° C)
Environmental Characteristics	Same Characteristics as Sepam Base Units

4-Wire RS485 Electrical Interface	
Standard	EIA 4-Wire RS485 Differential
Distributed Power Supply	External, 12 V DC or 24 V DC ±10%
Power Consumption	16 mA in Receiving Mode
	40 mA Maximum in Sending Mode

Maximum Length of 4-wire RS485 Network with Standard Cable

Number of Sepam Relay Units	Maximum Length with 12 V DC Power Supply	Maximum Length with 24 V DC Power Supply
5	1000 ft (320 m)	3300 ft (1000 m)
10	590 ft (180 m)	2500 ft (750 m)
20	520 ft (160 m)	1500 ft (450 m)
25	410 ft (125 m)	1200 ft (375 m)

Description and Dimensions

(A) and (B) Terminal blocks for network cable

(C) RJ45 socket to connect the interface to the base unit with a CCA612 cord

(D) Terminal block for a separate auxiliary power supply (12 V DC or 24 V DC)

(t) Grounding terminal

1 Link activity LED, flashes when communication is active (sending or receiving in progress).

2 Jumper for 4-wire RS485 network line-end impedance matching with load resistor (Rc = 150 Ω), to be set to:
- ■ ~~Rc~~, if the module is not at one end of the network (default position)
- ■ Rc, if the module is at one end of the network

3 Network cable clamps
inner diameter of clamp = 0.24 in (6 mm)

Connection

- ■ Connection of network cable to screw-type terminal blocks (A) and (B)
- ■ Connection of the grounding terminal by
  - □ Tinned copper braid with cross-section ⩾ 0.0093 in² (6 mm²), AWG 10
  - □ Or, cable with cross-section ⩾ 0.0039 in² (2.5 mm²), AWG 12
    - Length ⩽ 7.9 in (200 mm), fitted with a 0.16 in (4 mm) ring lug
    - Check the tightness (maximum tightening torque 2.2 Nm or 19.5 lb-in)
- ■ The interfaces are fitted with clamps to hold the network cable and recover shielding at the incoming and outgoing points of the network cable:
  - □ The network cable must be stripped
  - □ The cable shielding braid must be around and in contact with the clamp
- ■ The interface is to be connected to connector (C) on the base unit using a 9.8 ft (3 m) CCA612 cord (green fittings)
- ■ The interfaces are to be supplied with 12 V DC or 24 V DC
- ■ The ACE959 can be connected to a separate distributed power supply (not included in shielded cable)
  - □ Terminal block (D) is used to connect the distributed power supply module

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- ■ Only qualified personnel should install this equipment, after reading this entire set of instructions and checking the characteristics of the device.
- ■ NEVER work alone.
- ■ Check that the temperature sensors are isolated from dangerous voltages.

Failure to follow these instructions will result in death or serious injury.

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ACE937
Fiber Optic Interface

PE50024

ACE937 Fiber Optic Connection Interface

Function

The ACE937 interface is used to connect the Sepam™ relay to a fiber optic communication star system. This remote module is connected to the Sepam base unit by a CCA612 cord.

Characteristics

ACE937 Module	
Weight	0.22 lb (0.1 kg)
Assembly	On Symmetrical DIN rail
Power Supply	Supplied by Sepam
Operating Temperature	-13° to +158° F (-25° to +70° C)
Environmental Characteristics	Same Characteristics as Sepam Base Units

Fiber Optic Interface	
Fiber Type	Graded-Index Multimode Silica
Wavelength	820 nm (Invisible Infrared)
Type of Connector	ST (BFOC Bayonet Fiber Optic Connector)

Fiber Optic Diameter (µm)	Numerical Aperture (NA)	Maximum Attenuation (dBm/km)	Minimum optical Power Available (dBm)	Maximum Fiber Length
50/125	0.2	2.7	5.6	2300 ft (700 m)
62.5/125	0.275	3.2	9.4	5900 ft (1800 m)
100/140	0.3	4	14.9	9200 ft (2800 m)
200 (HCS)	0.37	6	19.2	8500 ft (2600 m)

Maximum length calculated with:
- Minimum optical power available
- Maximum fiber attenuation
- Losses in 2 ST connectors: 0.6 dBm
- Optical power margin: 3 dBm (according to IEC 60870 standard).

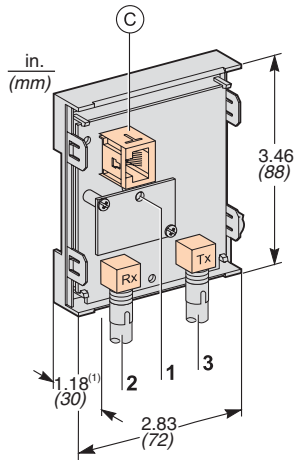
Example for a 62.5/125 µm fiber
Lmax = (9.4 - 3 - 0.6)/3.2 = 1.12 mi (1.8 km)

⚠ CAUTION

HAZARD OF BLINDING
Never look directly into the end of the fiber optic.

Failure to follow this instruction can cause serious injury.

DE80037



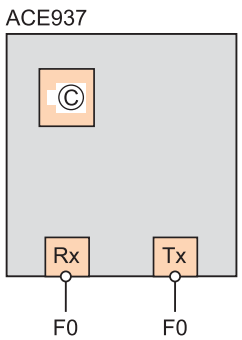
(1) *70 mm (2.8 in) with CCA612 Cord Connected*

Description and Dimensions

(C) RJ45 socket to connect the interface to the base unit with a CCA612 cord.

1 Link activity LED, flashes when communication is active (sending or receiving in progress).
2 Rx, female ST type connector (Sepam receiving).
3 Tx, female ST type connector (Sepam sending).

DE51666



Connection

- The sending and receiving fiber optic fibers must be equipped with male ST type connectors
- Fiber optics screw-locked to Rx and Tx connectors

The interface is to be connected to connector (C) on the base unit using a 9.8 ft (3 m) CCA612 cord (green fittings).

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH
- Only qualified personnel should install this equipment, after reading this entire set of instructions and checking the characteristics of the device.
- NEVER work alone.
- Check that the temperature sensors are isolated from dangerous voltages.

Failure to follow these instructions will result in death or serious injury.

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ACE969TP and ACE969FO Multi-Protocol Interfaces

PE50470

ACE969TP Communication Interface

PE50471

ACE969FO Communication Interface

Function

The ACE969 multi-protocol communication interfaces for Sepam™ Series 20, Sepam series 40 and Sepam series 80 have two communication ports to connect a Sepam to two independent communication networks:

- The S-LAN (Supervisory Local Area Network) port is used to connect Sepam to a communication network dedicated to supervision, using one of the three following protocols (protocol is selected at the time of Sepam parameter setting):
  - IEC 60870-5-103
  - DNP3
  - Modbus RTU
- The E-LAN (Engineering Local Area Network) port, reserved for Sepam remote parameter setting and operation using the SFT2841 software.

There are two versions of the ACE969 interfaces, which are identical except for the S-LAN port:

- ACE969TP
  - Twisted Pair
  - For connection to an S-LAN network using a 2-wire RS485 serial link
- ACE969FO
  - Fiber Optic
  - For connection to an S-LAN network using a fiber-optic connection (star or ring)

The E-LAN port is always a 2-wire RS485 type port

6

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ACE969TP and ACE969FO Multi-Protocol Interfaces

Characteristics

ACE969 Module		
Technical Characteristics		
Weight	0.628 lb (0.285 kg)	
Assembly	On Symmetrical DIN rail	
Operating Temperature	-13° to +158° F (-25° to +70° C)	
Environmental Characteristics	Same Characteristics as Sepam™ Base Units	
Power Supply		
Voltage	24–250 V DC	110–240 V AC
Range	-20%/+10%	-20%/+10%
Maximum Burden	2 W	3 VA
Inrush Current	< 10 A 100 µs	
Acceptable Ripple Content	12%	
Acceptable Momentary Outages	20 ms	
2-wire RS485 Communication Ports		
Electrical Interface		
Standard	EIA 2-wire RS485 Differential	
Distributed Power Supply	External, 12 V DC or 24 V DC ±10%	
Power Consumption	16 mA in Receiving Mode	
	40 mA in Sending Mode	
Max. Number of Sepam Units	25	

Maximum Length of 2-Wire RS485 Network		
Number of Sepam Units	**With Distributed Power Supply**	
	12 V DC	**24 V DC**
5	1000 ft (320 m)	3300 ft (1000 m)
10	590 ft (180 m)	2500 ft (750 m)
20	430 ft (130 m)	1500 ft (450 m)
25	410 ft (125 m)	1200 ft (375 m)

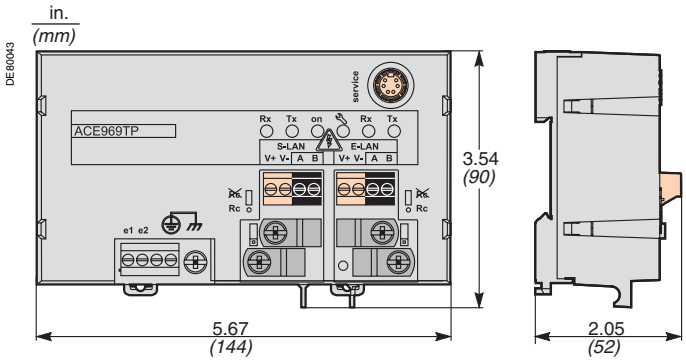
Fiber Optic Communication Port				
Fiber Optic Interface				
Fiber Type	Graded-Index Multimode Silica			
Wavelength	820 nm (Invisible Infrared)			
Type of Connector	ST (BFOC Bayonet Fiber Optic Connector)			

Maximum Length of Fiber Optic Network				
Fiber Diameter (µm)	**Numerical Aperture (NA)**	**Attenuation (dBm/km)**	**Minimum Optical Power Available (dBm)**	**Maximum Fiber Length**
50/125	0.2	2.7	5.6	2300 ft (700 m)
62.5/125	0.275	3.2	9.4	5900 ft (1800 m)
100/140	0.3	4	14.9	9200 ft (2800 m)
200 (HCS)	0.37	6	19.2	8500 ft (2600 m)

Maximum length calculated with:
- Minimum optical power available
- Maximum fiber attenuation
- Losses in 2 ST connectors: 0.6 dBm
- Optical power margin: 3 dBm (according to IEC 60870 standard)

Example for a 62.5/125 µm fiber
Lmax = (9.4 - 3 - 0.6)/3.2 = 1.12 mi (1.8 km)

Dimensions



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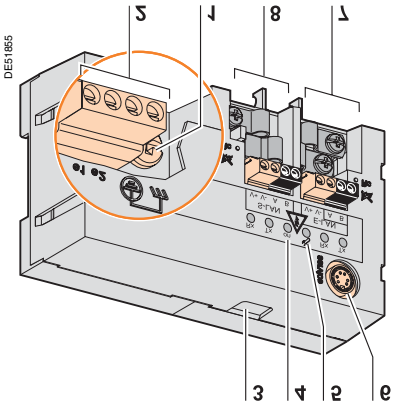
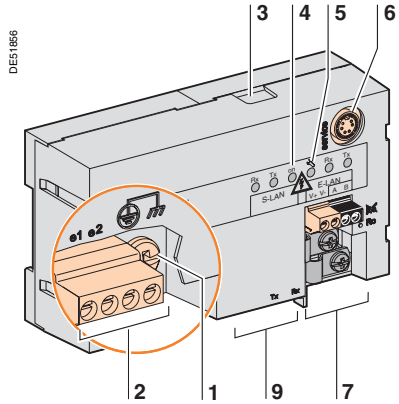
ACE969TP and ACE969FO Multi-Protocol Interfaces
Description

ACE969 Communication Interfaces

ACE969TP



ACE969FO

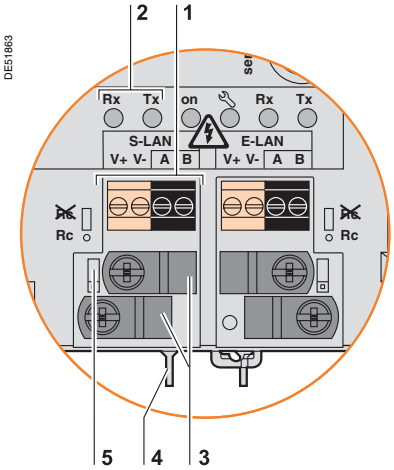


1 Grounding terminal using supplied braid
2 Power-supply terminal block
3 RJ45 socket to connect the interface to the base unit with a CCA612 cord
4 Green LED: ACE969 energized
5 Red LED: ACE969 interface status
- LED off: ACE969 set up and communication operational
- LED flashing: ACE969 not set up or setup incorrect
- LED remains on: ACE969 failed

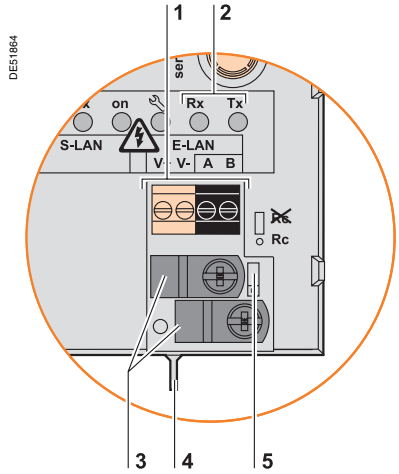
6 Service connector: reserved for software upgrades
7 E-LAN 2-wire RS485 communication port (ACE969TP and ACE969FO)
8 S-LAN 2-wire RS485 communication port (ACE969TP)
9 S-LAN fiber-optic communication port (ACE969FO)

2-Wire RS485 Communication Ports

S-LAN Port (ACE969TP)



E-LAN Port (ACE969TP or ACE969FO)



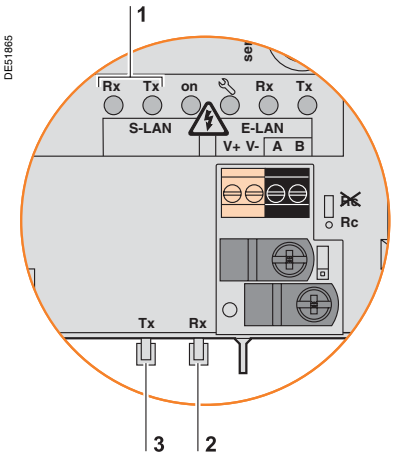
1 2-wire RS485 network terminal block:
- 2 black terminals: connection of 2-wire RS485 twisted pair
- 2 green terminals: connection of twisted pair for distributed power supply

2 LEDs:
- Flashing Tx LED: Sepam™ sending
- Flashing Rx LED: Sepam receiving

3 Clamps and recovery of shielding for two network cables, incoming and outgoing (inner diameter of clamps = 0.24 in (6 mm)
4 Fixing stud for network cable ties
5 Jumper for 2-wire RS485 network line-end impedance matching with load resistor (Rc = 150 ω), to be set to:
- ~~Rc~~, if the interface is not at one end of the network (default position)
- Rc, if the interface is at one end of the network

Fiber Optic Communication Port

S-LAN Port (ACE969FO)



1 LEDs:
- Flashing Tx LED: Sepam sending
- Flashing Rx LED: Sepam receiving

2 Rx, female ST type connector (Sepam receiving)
3 Tx, female ST type connector (Sepam sending)

6

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ACE969TP and ACE969FO Multi-Protocol Interfaces
Connection

Power Supply and Sepam™ Relays

- The ACE969 interface connects to connector C on the Sepam base unit using a 9.8 ft (3 m) CCA612 cord (green RJ45 fittings)
- The ACE969 interface must be supplied with 24–250 V DC or 110–230 V AC

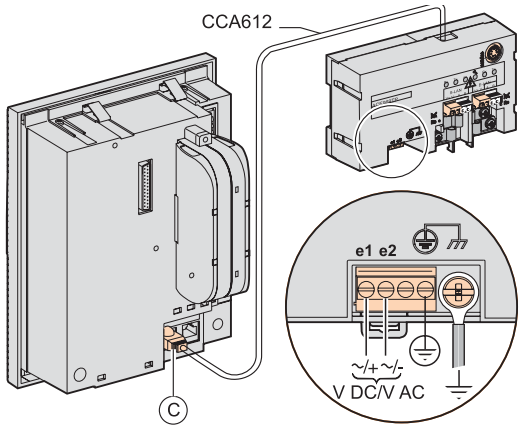
⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

Failure to follow these instructions will result in death or serious injury.

DE52166



Terminals	Type	Wiring
e1-e2 - Supply	Screw Terminals	■ Wiring with no fittings: □ 1 wire with maximum cross-section 0.0003–0.0039 in² (0.2–2.5 mm²), ⩾ AWG 24-12 □ 2 wires with maximum cross-section 0.0003–0.0016 in² (0.2–1 mm²), ⩾ AWG 24-18 □ Stripped length: 0.31–0.39 in (8–10 mm) ■ Wiring with fittings: □ Recommended wiring with Telemecanique fitting: - DZ5CE015D for 1 wire 1.5 mm², AWG 16 - DZ5CE025D for 1 wire 0.0039 in² (2.5 mm²), AWG 12 - AZ5DE010D for 2 wires 0.0016 in² (1 mm²), AWG 18 □ Cable length: 0.32 in (8.2 mm) □ Stripped length: 0.31 in (8 mm)
DE51962 ⏚ Protective Ground	Screw Terminal	1 Green/yellow wire, max. length 9.8 ft (3 m) and maximum cross-section 0.0039 in² (2.5 mm²), AWG 12
DE51845 Functional Ground	0.16 in (4 mm) Ring Lug	Grounding braid, supplied for connection to cubicle grounding

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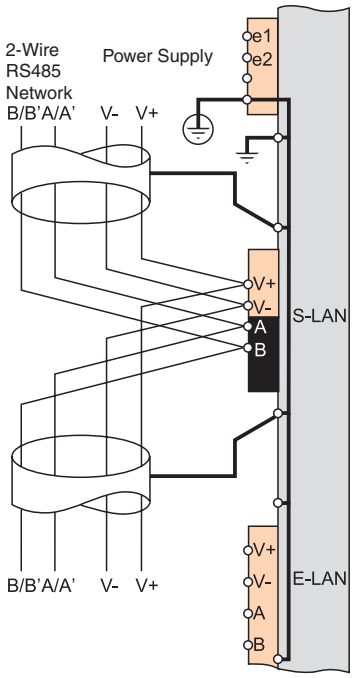
ACE969TP and ACE969FO Multi-Protocol Interfaces
Connection

DE52078

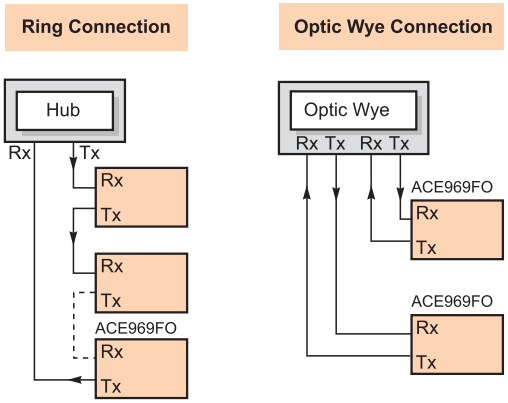


2-wire RS485 Communication Ports (S-LAN or E-LAN)

- Connection of RS485 twisted pair (S-LAN or E-LAN) to black terminals A and B
- Connection of twisted pair for distributed power supply to green terminals V+ and V-
- The interfaces are fitted with clamps to hold the network cable and recover shielding at the incoming and outgoing points of the network cable:
  - The network cable must be stripped
  - The cable shielding must be around and in contact with the clamp
  - Shielding continuity of incoming and outgoing cables is ensured by the electrical continuity of the clamps
- All cable clamps are linked by an internal connection to the grounding terminals of the ACE969 interface
  - Protective and functional grounding
  - The shielding of the RS 485 cables is grounded as well
- On the ACE969TP interface, the cable clamps for the S-LAN and E-LAN RS485 networks are grounded

Note: *The shield connection should be grounded at only one end of the serial daisy chain.*

DE52165



Fiber Optic Communication Port (S-LAN)

⚠ CAUTION

HAZARD OF BLINDING
Never look directly into the fiber optic.

Failure to follow this instruction can cause serious injury.

The fiber optic connection can be made:
- Point-to-point to an optic star system
- In a ring system (active echo)

The sending and receiving fiber optic fibers must be equipped with male ST type connectors. The fiber optics are screw-locked to Rx and Tx connectors.

6

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ACE9092
RS232/RS485 Converter

PE50035

ACE9092 RS232/RS485 Converter

Function

The ACE9092 converter is used to connect a master/central computer equipped with a V24/RS232 type serial port as a standard feature to stations connected to a 2-wire RS485 network.

Without requiring any flow control signals, after the parameters are set, the ACE9092 converter performs conversion, network polarization and automatic dispatching of frames between the master and the stations by two-way simplex (half-duplex, single-pair) transmission.

The ACE9092 converter also provides a 12 V DC or 24 V DC supply for the distributed power supply of the Sepam™ relay ACE9492, ACE959 or ACE969 interfaces. The communication settings should be the same as the Sepam and supervisor communication settings.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

Failure to follow these instructions will result in death or serious injury.

Characteristics

Mechanical Characteristics	
Weight	0.617 lb (0.280 kg)
Assembly	On Symmetrical or Asymmetrical DIN rail
Electrical Characteristics	
Power Supply	110–240 V AC ± 10%, 47–63 Hz
Galvanic Isolation between ACE Power Supply and Frame, and between ACE Power Supply and Interface Supply	2000 Vrms, 60 Hz, 1 min
Galvanic Isolation between RS232 and RS485 Interfaces	1000 Vrms, 60 Hz, 1 min
Protection by Time-Delayed Fuse 5 mm x 20 mm (0.2 in x 0.79 in)	1 A Rating
Communication and Sepam Interface Distributed Supply	
Data Format	11 Bits: 1 start, 8 data, 1 parity, 1 stop
Transmission Delay	< 100 ns
Distributed Power Supply for Sepam Interfaces	12 V DC or 24 V DC
Maximum Number of Sepam Interfaces with Distributed Supply	12
Environmental Characteristics	
Operating Temperature	23–131° F (-5° to +55°C)

Electromagnetic Compatibility	IEC Standard	Value
Fast Transient Bursts, 5 ns	60255-22-4	4 kV with Capacitive Tie Breaker in Common Mode 2 kV with Direct Tie Breaker in Common Mode 1 kV with Direct Tie Breaker in Differential Mode
1 MHz Damped Oscillating Wave	60255-22-1	1 kV Common Mode 0.5 kV Differential Mode
1.2/50 µs Impulse Waves	60255-5	3 kV Common Mode 1 kV Differential Mode

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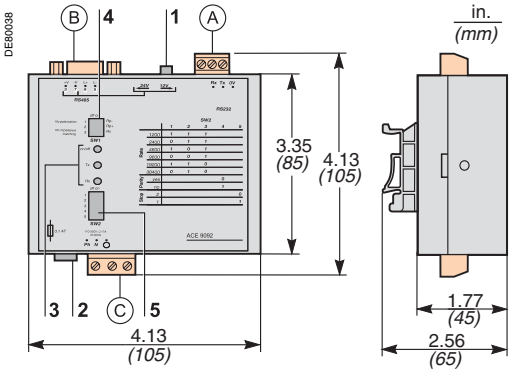
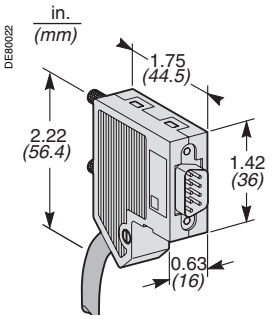
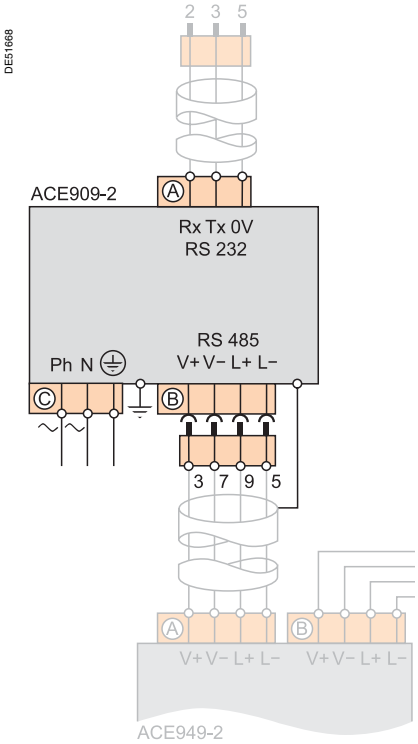
ACE9092
RS232/RS485 Converter





Male 9-Pin Sub-D Connector Supplied with the ACE9092



Description and Dimensions

(A) Terminal block for RS232 link limited to 33 ft (10 m).

(B) Female 9-pin sub-D connector to connect to the 2-wire RS485 network, with distributed power supply.
1 screw-type male 9-pin sub-D connector is supplied with the converter.

(C) Power-supply terminal block.

1 Distributed power supply voltage selector switch, 12 V DC or 24 V DC.
2 Protection fuse, unlocked by a 1/4 turn.
3 LEDs:
- ON/OFF: on if ACE9092 is energized
- Tx: on if RS232 sending by ACE9092 is active
- Rx: on if RS232 receiving by ACE9092 is active

4 SW1, parameter setting of 2-wire RS485 network polarization and line impedance matching resistors.

Function	SW1/1	SW1/2	SW1/3
Polarization at 0 V via Rp -470 Ω	ON		
Polarization at 5 V via Rp +470 Ω		ON	
2-Wire RS485 Network Impedance Matching by 150 Ω Resistor			ON

5 SW2, parameter setting of asynchronous data transmission rate and format (same parameters as for RS232 link and 2-wire RS485 network).

Rate (Baud)	SW2/1	SW2/2	SW2/3		
1200	1	1	1		
2400	0	1	1		
4800	1	0	1		
9600	0	0	1		
19200	1	1	0		
38400	0	1	0		
Format				**SW2/4**	**SW2/5**
With Parity Check				0	
Without Parity Check				1	
1 Stop Bit (Compulsory for Sepam™)					0
2 Stop Bits					1

Converter Configuration When Delivered
- 12 V DC distributed power supply
- 11-bit format, with parity check
- 2-wire RS485 network polarization and impedance matching resistors activated

Connection

RS232 Link
- To 0.0039 in² (2.5 mm²), AWG 12, screw type terminal block (A)
- Maximum length 33 ft (10 m)
- Rx/Tx: RS232 receiving/sending by ACE9092
- 0V: Rx/Tx common, do not ground

2-Wire RS485 Link with Distributed Power Supply
- To connector (B) female 9-pin sub-D
- 2-wire RS485 signals: L+, L-
- Distributed power supply: V+ = 12 V DC or 24 V DC, V- = 0 V.

Power Supply
- To 0.0039 in² (2.5 mm²), AWG 12, screw type terminal block (C)
- Reversible phase and neutral
- Grounded via terminal block and metal case (ring lug on back of case)

6

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ACE919CA and ACE919CC RS485/RS485 Converters

PE50036

ACE919CC RS485/RS485 Converter

Function

The ACE919 converters are used to connect a master/central computer equipped with an RS485 type serial port as a standard feature to stations connected to a 2-wire RS485 network.
Without requiring any flow control signals, the ACE919 converters perform network polarization and impedance matching.
The ACE919 converters also provide a 12 V DC or 24 V DC supply for the distributed power supply of the Sepam™ ACE9492, ACE959 or ACE969 interfaces.
There are 2 types of ACE919 converter:

- ACE919CC, DC-powered
- ACE919CA, AC-powered.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

Failure to follow these instructions will result in death or serious injury.

Characteristics

Mechanical Characteristics		
Weight	0.617 lb (0.280 kg)	
Assembly	On Symmetrical or Asymmetrical DIN rail	
Electrical Characteristics	**ACE919CA**	**ACE919CC**
Power Supply	110–250 V AC ±10%, 47 to 63 Hz	24–48 V DC ±20%
Protection by Time-Delayed Fuse 0.2 x 0.79 in (5 x 20 mm)	1 A Rating	1 A Rating
Galvanic Isolation between ACE Power Supply and Frame, and Between ACE Power Supply and Interface Supply		2000 Vrms, 60 Hz, 1 min
Communication and Sepam Interface Distributed Supply		
Data Format	11 bits: 1 Start, 8 Data, 1 Parity, 1 Stop	
Transmission Delay	< 100 ns	
Distributed Power Supply for Sepam Interfaces	12 V DC or 24 V DC	
Maximum Number of Sepam Interfaces with Distributed Supply	12	
Environmental Characteristics		
Operating Temperature	23°–131° F (-5° to +55° C)	

Electromagnetic Compatibility	IEC Standard	Value
Fast Transient Bursts, 5 ns	60255-22-4	4 kV with Capacitive Tie Breaker in Common Mode 2 kV with Direct Tie Breaker in Common Mode 1 kV with Direct Tie Breaker in Differential Mode
1 MHz Damped Oscillating Wave	60255-22-1	1 kV Common Mode 0.5 kV Differential Mode
1.2/50 µs Impulse Waves	60255-5	3 kV Common Mode 1 kV Differential Mode

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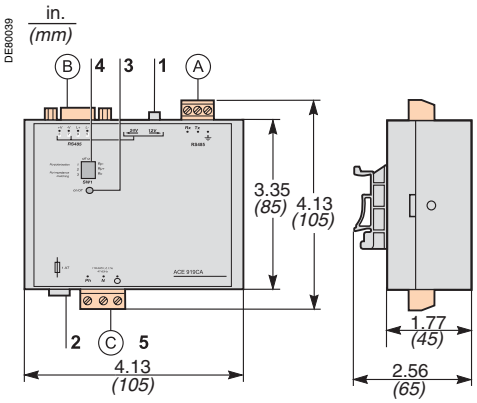
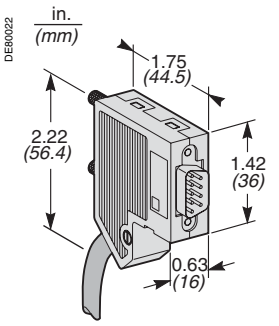
ACE919CA and ACE919CC RS485/RS485 Converters





Male 9-Pin Sub-D Connector Supplied with the ACE919

Description and Dimensions

(A) Terminal block for 2-wire RS485 link without distributed power supply.

(B) Female 9-pin sub-D connector to connect to the 2-wire RS485 network, with distributed power supply.
1 screw-type male 9-pin sub-D connector is supplied with the converter.

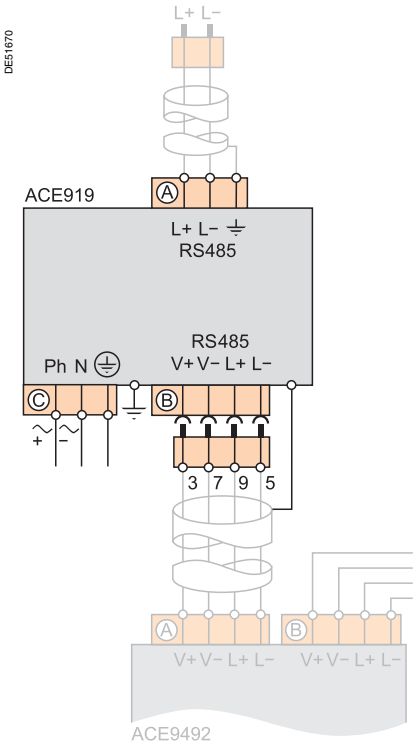
(C) Power supply terminal block.

1 Distributed power supply voltage selector switch, 12 V DC or 24 V DC.
2 Protection fuse, unlocked by a 1/4 turn.
3 ON/OFF LED: on if ACE919 is energized.
4 SW1, parameter setting of 2-wire RS485 network polarization and line impedance matching resistors.

Function	SW1/1	SW1/2	SW1/3
Polarization at 0 V via Rp -470 Ω	ON		
Polarization at 5 V via Rp +470 Ω		ON	
2-Wire RS485 Network Impedance Matching by 150 Ω Resistor			ON

Converter configuration when delivered
- 12 V DC distributed power supply
- 2-wire RS485 network polarization and impedance matching resistors activated

Connection



2-Wire RS485 Link without Distributed Power Supply
- To 0.0039 in² (2.5 mm²) (AWG 12) screw type terminal block (A)
- L+, L-: 2-wire RS485 signals
- ⏚ Shielding

2-Wire RS485 Link with Distributed Power Supply
- To connector (B) female 9-pin sub-D
- 2-wire RS485 signals: L+, L-
- Distributed power supply: V+ = 12 V DC or 24 V DC, V- = 0 V

Power Supply
- To 0.0039 in² (2.5 mm²) (AWG 12) screw type terminal block (C)
- Reversible phase and neutral (ACE919CA)
- Grounded via terminal block and metal case (ring lug on back of case)

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User-Machine Interfaces

Sepam™ Relay User-Machine Interfaces

Two different levels of user-machine interface (UMI) are offered on the front panel of Sepam relays:

- Basic UMI, with LEDs, for installations operated via a remote system with no need for local operation
- Advanced UMI, with a keypad and a graphic LCD display, giving access to all the information necessary for local operation and Sepam™ relay parameter setting

SFT2841 Setting and Operating Software

The UMI on the front panel of Sepam relays can be connected to the SFT2841 PC software tool, which is used for all Sepam relay parameter setting, local operation, and customization functions.

The SFT2841 setting and operating software is supplied on CD-ROM, along with the SFT2826 program for recovering disturbance recording files, the interactive introduction to the Sepam relay range, and all the Sepam relay documentation (in PDF format).

The CCA783 PC connecting cord (ordered separately) connects the PC to the port on the Sepam relay front panel, so that the SFT2841 package can be used in point-to-point connected mode.

PE50336

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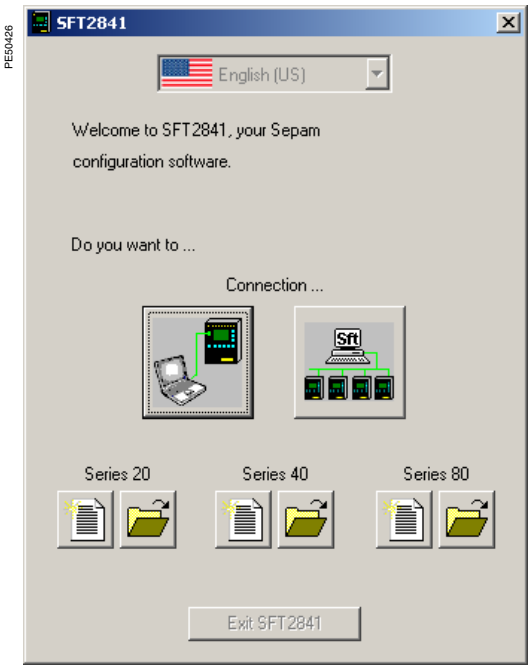
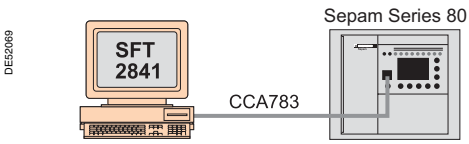
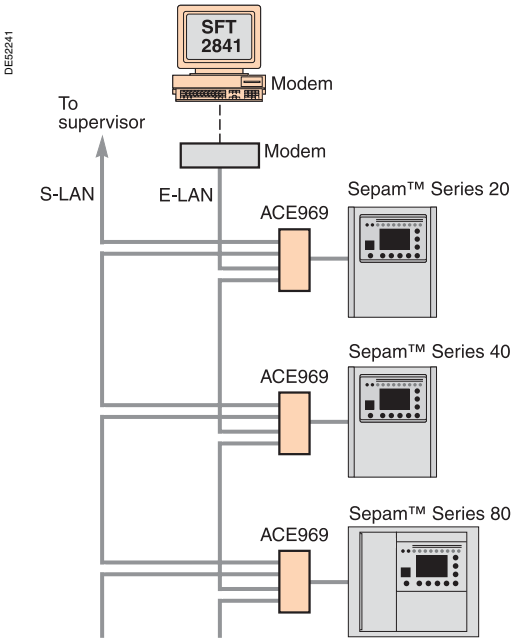
SFT2841 Setting and Operating Software
Welcome Window



SFT2841 Welcome Window



SFT2841 Connected to a Single Sepam Unit



SFT2841 Connected to a Sepam Network

Description

The SFT2841 welcome window opens when the program is launched. It lets you choose the language for the SFT2841 screens, and provides access to the Sepam™ parameter and protection setting files:

- In disconnected mode, you can open or create a parameter and protection setting file for a Sepam Series 20, Sepam Series 40 or Sepam Series 80
- While connected to a single Sepam unit, you can access the parameter and protection setting file for the Sepam unit currently connected to the PC
- While connected to a Sepam network, you can access the parameter and protection setting files for a group of Sepam units connected to the PC via a communication network

Language of SFT2841 Screens

The SFT2841 software user can opt to run the program in US English, UK English, French, or Spanish. The desired language is selected at the top of the **SFT2841** welcome window.

Using SFT2841 in Disconnected Mode

Disconnected mode allows you to prepare parameters and settings files for Sepam Series 20, Sepam Series 40 and Sepam Series 80 prior to commissioning. The parameter and protection setting files prepared in disconnected mode will be downloaded later to the Sepam units when in connected mode.

- To create a new parameter and protection setting file, click on the icon for the relevant Sepam family (Sepam Series 20, Sepam Series 40 or Sepam Series 80)
- To open an existing parameter and protection setting file, click on the icon for the relevant Sepam family (Sepam Series 20, Sepam Series 40 or Sepam Series 80)

Using SFT2841 Connected to a single Sepam Unit

During commissioning, the SFT2841 software is used while **Connected to a single Sepam unit** to:

- Upload, download, and modify Sepam relay parameters and settings
- Have all the measurements and supporting data available for commissioning

The PC loaded with the SFT2841 software is connected to the connection port on the front panel of the Sepam relay via an RS232 port using the CCA783 cord.

To open the parameter and protection setting file on the Sepam once it is connected to the PC, click on the icon.

Using SFT2841 Connected to a Sepam Network

Connected to a Sepam network mode is used during operation to:

- Manage the protection system
- Check the status of the power supply
- Diagnose any incident occurring on the power supply

The PC loaded with the SFT2841 software is connected to a group of Sepam units via a communication network (connection via serial link, telephone line, or Ethernet). This network forms the E-LAN engineering network.

The connection window allows configuration of the Sepam network, and provides access to the parameter and protection setting files of the Sepam units on the network.

To open the connection window, click on the icon.

See "Configuration of a Sepam network" for details of how to configure the E-LAN engineering network from the connection window.

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SFT2841 Setting and Operating Software
Presentation

All the setting and operating functions are available on the screen of a PC equipped with the SFT2841 software tool and connected to the PC connection port on the front panel of Sepam™ (run in a Windows 98, NT, 2000, or XP environment).

All the data used for the same task are grouped together in the same screen to facilitate operation. Menus and icons are used for fast, direct access to the required information.

Current Operation
- Display of all metering and operation data
- Display of alarm messages with the time of appearance (date, hr, min, s)
- Display of diagnosic data such as: tripping current, number of switchgear operations and cumulative breaking current
- Display of all the protection and parameter settings
- Display of the logic status of inputs, outputs, and LEDs

This software is suitable for occasional local operation, meeting the needs of demanding personnel who require fast access to all the information.

Parameter and Protection Setting (1)
- Display and setting of all the parameters of each protection function on the same page
- Program logic parameter setting, parameter setting of general installation and Sepam data
- Input data can be prepared ahead of time and transferred into the corresponding Sepam units in a single operation (downloading function)

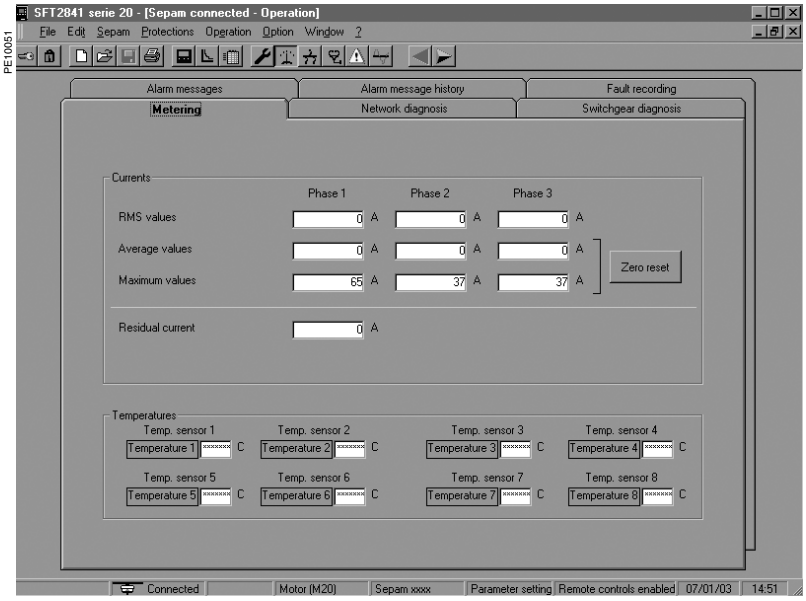
Main functions performed by SFT2841
- Modification of passwords
- Entry of general characteristics (ratings, integration period, etc.)
- Setting Sepam relay date and time
- Entry of protection settings
- Changing of program logic assignments
- Enabling/disabling of functions
- Saving of files

Saving
- Protection and parameter setting data can be saved
- Printing of reports is possible as well.

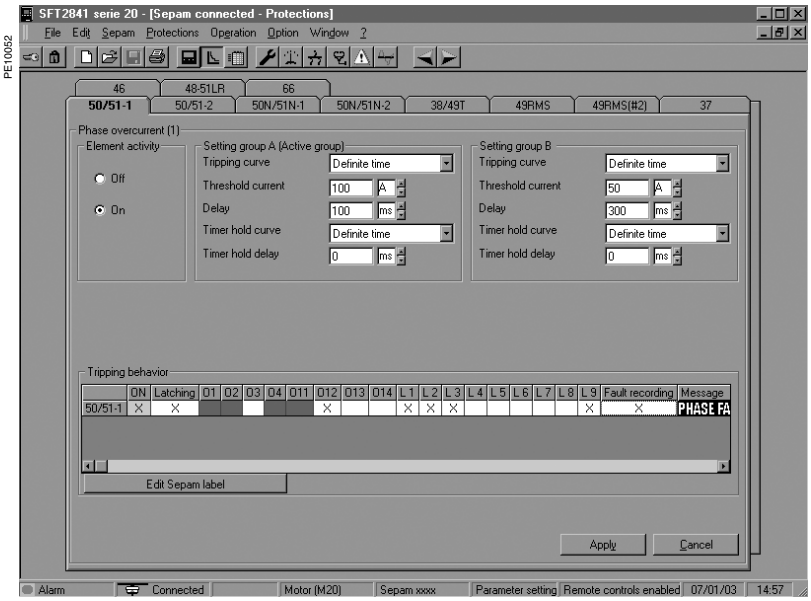
This software can also be used to recover disturbance recording files and provide a graphic display.

Operating Assistance
Access from all the screens to a help section which contains all the technical data required for Sepam relay installation and use.

(1) *Modes accessed via 2 passwords (protection setting level, parameter setting level).*



Example of a measurement display screen (Sepam M20)



Example of a phase overcurrent protection setting screen

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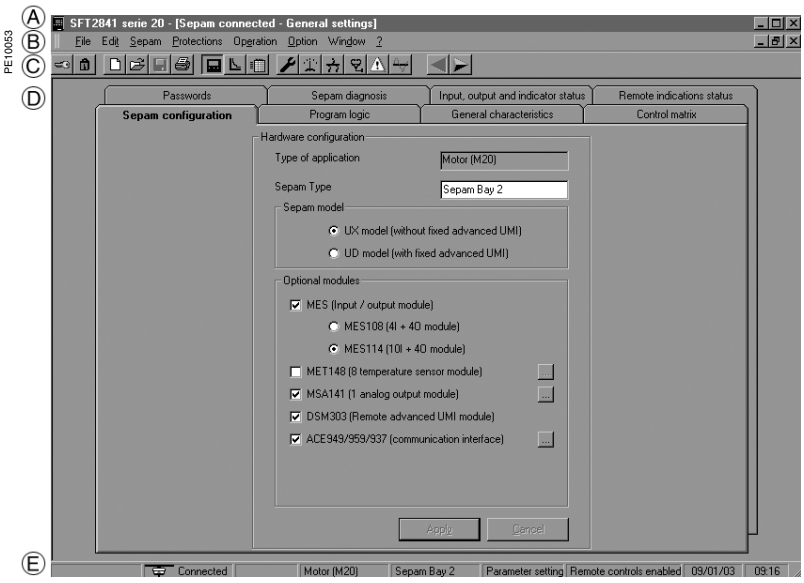
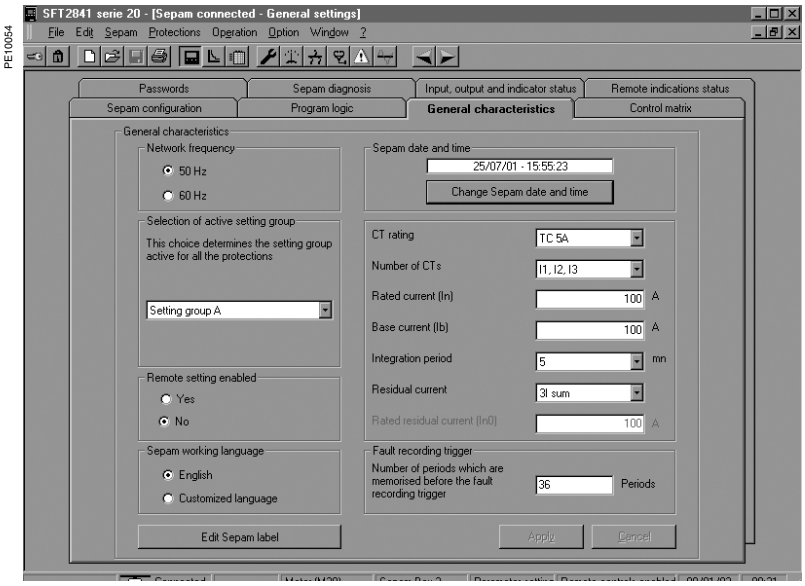
SFT2841 Setting and Operating Software
General Screen Organization

A Sepam™ document is displayed on the screen via a graphic interface that has conventional Windows features. All the SFT2841 software screens are set up in the same way, and include:

- Ⓐ :Title bar
  - Name of the application (SFT2841)
  - Identification of the Sepam document displayed
  - Window manipulation handles
- Ⓑ :Menu bar
  - To access all SFT2841 software functions
  - Unavailable functions are dimmed)
- Ⓒ :Toolbar
  - Group of contextual icons for main functions
  - Also accessed via the menu bar
- Ⓓ :Work zone
  - Tab boxes
- Ⓔ :Status bar
  - With information relating to the active document:
    - Alarm on
    - Identification of the connection window
    - SFT2841 operating mode, connected or disconnected
    - Type of Sepam
    - Sepam editing identification
    - Identification level
    - Sepam operating mode
    - PC date and time



Example of Sepam configuration screen



Example of general characteristics screen

Guided Navigation

A guided navigation mode aids the in process of entering Sepam relay parameter and protection settings. It allows users to go through the data input screens in the natural order.

The sequencing of screens in guided mode is controlled by clicking on 2 icons on the toolbar Ⓒ :

- ◀: To go back to the previous screen
- ▶: To go to the next screen

The screens are linked up in the following order:

1. Sepam configuration
2. Program logic
3. General characteristics
4. Setting screens for the protection functions available, according to the type of Sepam
5. Control matrix

On-Line Help

The user can refer to the on-line help at any time via the "?" command in the menu bar.

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SFT2841 Setting and Operating Software
Use of the Software

Not Connected to Sepam™ Mode

Sepam Parameter and Protection Setting

The parameter and protection setting of a Sepam using SFT2841 consists of preparing the Sepam file containing all the characteristics that are specific to the application; a file that is then downloaded into the Sepam relay at the time of commissioning.

⚠ CAUTION

HAZARD OF UNINTENDED OPERATION

- The device must only be configured and set by qualified personnel, using the results of the installation protection system study.
- During commissioning of the installation and after any modification, check that the Sepam configuration and protection function settings are consistent with the results of this study.

Failure to follow these instructions can cause equipment damage.

Operating mode:

1 Create a Sepam file for the type of Sepam to be set up. (The newly created file contains the Sepam factory-set parameter and protection settings).

2 Modify the "Sepam" page function sheet parameters and the "Protections" page function sheet protection settings:

- All the information relating to a function is grouped together on a single screen
- We recommend entering all the parameter and protection settings in the natural screen order suggested by the guided navigation tool.

Entry of parameter and protection settings

- The parameter and protection setting input fields correspond to the type of value:
  - □selection buttons
  - □numerical value input fields
  - □dialog box (Combo box)
- The modifications made to a function sheet are to be "Applied" or "Canceled" before the user goes on to the following function sheet
- The consistency of the parameter and protection settings entered is checked:
  - □ A clear message specifies the inconsistent value in the function sheet opened
  - □ Values which become inconsistent following the modification of a parameter are replaced by "****" and must be corrected

Connected to Sepam Mode

Static Electric Discharge

When a laptop is used, given the risks inherent in the accumulation of static electricity, the customary precaution consists of discharging while in contact with a grounded metal frame before physically connecting the CCA783 cord.

Plugging into Sepam

- Plug the 9-pin connector (SUB-D type) into one of the PC communication ports
  - □ Configure the PC communication port via the "Communication port" function in the "Options" menu
- Plug the 6-pin connector (round minidin type) into the connector situated behind the blanking plate on the front panel of Sepam or the DSM303 module

Connection to Sepam

2 possibilities for setting up the connection between SFT2841 and the Sepam:

- Choice of "Connect to the Sepam" at the start-up of SFT2841
- "Connection" function in the "File" menu.

Once the connection with Sepam has been established, "Connected" appears in the status bar, and the Sepam connection window can be accessed in the work zone.

User Identification

The window intended for the entry of the 4-digit password is activated:

- Via the "Passwords" tab
- Via the "Identification" function in the "Sepam" menu
- Via the "Identification" icon .

The "Return to Operating mode" function in the "Passwords" tab removes access rights to parameter and protection setting mode.

Downloading of Parameters and Protection Settings

Parameter and protection setting files can only be downloaded to the connected Sepam relay in Parameter setting mode. Once the connection has been established, the procedure for downloading a parameter and protection setting file is as follows:

1 Activate the "Download Sepam" function in the "Sepam" menu

2 Select the *.rpg file which contains the data to be downloaded

3 Acknowledge the end of operation report

Return to Factory Settings

This operation (only possible in the Parameter setting mode, via the "Sepam" menu) is used to reset all general characteristics, protection settings, and control matrix settings back to their default values.

Uploading of Parameters and Protection Settings

The connected Sepam parameter and protection setting file can only be uploaded in Operating mode. Once the connection has been established, the procedure for uploading a parameter and protection setting file is as follows:

1 Activate the "Upload Sepam" function in the "Sepam" menu

2 Select the *.rpg file that is to contain the data to be uploaded

3 Acknowledge the end of operation report

Local Operation of Sepam

Connected to Sepam, SFT2841 offers all the local operating functions available in the advanced UMI screen, plus the following functions:

- Setting of Sepam internal clock, via the "General characteristics" tab

Note: The Sepam relay saves the date/time, in case the auxiliary power supply fails (< 24 hours)

- Implementation of the disturbance recording function, via the "OPG" menu: validation/blocking of the function, recovery of Sepam files, start-up of SFT2826
- Consultation of the history of the last 64 Sepam alarms, with time-tagging
- Access to Sepam diagnostic data, in the "Sepam" tab box, included in "Sepam diagnosis"

In Parameter setting mode, the switchgear diagnostic values can be modified.

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SFT2841 Setting and Operating Software
Configuration of a Sepam™ Network

Connection Window

The SFT2841 software connection window is used to:
- Select an existing Sepam™ network or configure a new one
- Set up the connection to the selected Sepam network
- Select one Sepam unit from the network and access its parameters, settings, and operation and maintenance information

Configuration of a Sepam Network

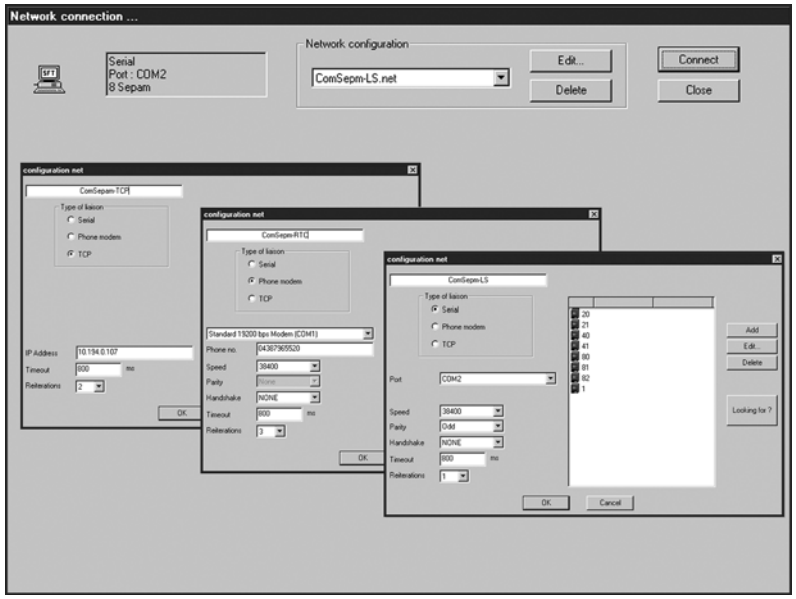
Several configurations can be defined for the various Sepam installations. A Sepam network configuration is identified by a name. It is saved on the SFT2841 PC in a file in the SFT2841 installation directory (default: C:\Program Files\Schneider\SFT2841\Net).

Configuration of a Sepam network is a two-part process:
- Configuration of the communication network
- Configuration of the Sepam units

Configuration of the Communication Network

To configure the communication network, first define:
- The type of link between the PC and the Sepam network
- The communication parameters, according to the type of link selected:
  - Direct serial link
  - Link via Ethernet TCP/IP
  - Link via telephone modem

PE50603



Configuration windows for the communication network, according to the type of link: serial link, modem link (STN) or Ethernet link (TCP)

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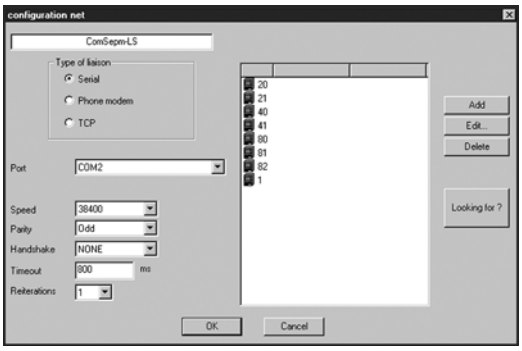
SFT2841 Setting and Operating Software
Configuration of a Sepam™ Network

PE50588



Configuration Window for the Serial Link Communication Network

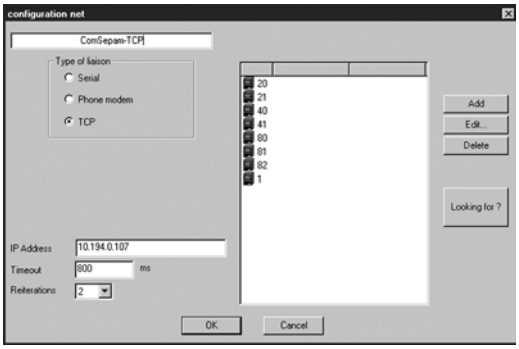
Direct Serial Link

The Sepam™ units are connected to an RS485 (or fiber-optic) multidrop network. Depending on the serial link interfaces available on the PC, the PC itself will be connected either directly to the RS485 network (or fiber-optic HUB), or via an RS232/RS485 converter (or fiber-optic converter).

Define these parameters:

- Port
  - Communication port used on the PC
- Speed
  - 4800 Baud
  - 9600 Baud
  - 19200 Baud
  - 38400 Baud
- Parity
  - None
  - Even
  - Odd
- Handshake
  - None
  - RTS
  - RTS-CTS
- Time-out
  - 100–3000 ms
- Number of retries
  - 1, 2, or 3

PE50589



Configuration Window for the Ethernet TCP/IP Communication Network

Link Via Ethernet TCP/IP

The Sepam units are connected to an RS485 multidrop network over an Ethernet Modbus TCP/IP gateway (e.g.: EGX gateway).

Configuration of the Modbus TCP/IP Gateway

See the setup manual for the gateway used. In general, the gateway should be assigned an IP address. The configuration parameters for the gateway's RS485 interface must be defined in accordance with the Sepam communication interface configuration:

- Speed
  - 4800 Baud
  - 9600 Baud
  - 19200 Baud
  - 38400 Baud
- Character Format
  - 8 data bits + 1 stop bit + parity (none, even, odd)

Configuration of Communication on SFT2841

When configuring a Sepam network on SFT2841, the following communication parameters must be defined:

- IP address of the remote Modbus TCP/IP gateway
- Time-out
  - 100–3000 ms

    A time-out of between 800 ms and 1000 ms is sufficient in most installations. Communication via the TCP/IP gateway may, however, be slowed if other applications require Modbus TCP/IP access at the same time. The time-out value should then be increased (2–3 seconds).
- Number of retries
  - 1, 2, or 3

Note 1: *SFT2841 uses the Modbus TCP/IP communication protocol. Although communication is IP-based, use of SFT2841 is restricted to a local installation network based on an Ethernet Local Area Network (LAN). The operation of SFT2841 over a Wide Area Network (WAN) cannot be guaranteed because of the presence of some routers or firewalls that may reject the Modbus protocol, causing communication times that would be incompatible with Sepam relays.*

Note 2: *SFT2841 allows Sepam protection settings to be modified, and direct activation of the outputs. These operations, which could involve the operation of electrical equipment (opening and closing), and thus put the safety of people and installations at risk, are protected by the Sepam password. In addition to this protection, the E-LANs and S-LANs must be designed as private networks, protected from external actions by all suitable methods.*

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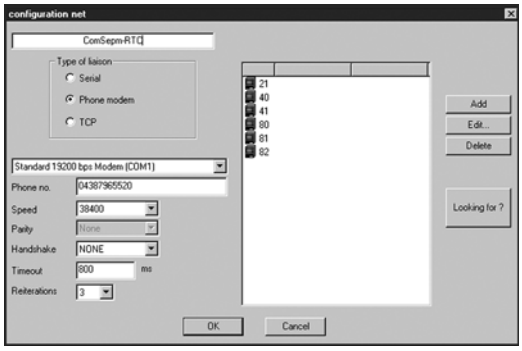
PE50990



Configuration Window for the Communication network via Telephone Modem

Link Via Telephone Modem

The Sepam™ units are connected to an RS485 multidrop network using an industrial STN modem: the "called modem". Configure it, with AT commands from a PC using HyperTerminal, the configuration tool that may have been supplied with the modem, or by setting switches (see the modem manufacturer's manual).

The PC can use an internal or an external modem. This modem on the PC side is always the calling modem. It must be installed and configured in accordance with the Windows modem installation procedure.

Configuration of the Calling Modem in SFT2841

When configuring a Sepam network, SFT2841 displays the list of all the modems installed on the PC. The communication parameters to be defined are:

- Modem
  - Select one of the modems listed by SFT2841
- Telephone Number
  - Number of the remote modem to be called
- Speed
  - 4800 Baud
  - 9600 Baud
  - 19200 Baud
  - 38400 Baud
- Parity
  - None (not adjustable)
- Handshake
  - None
  - RTS
  - RTS-CTS
- Time-out
  - 100–3000 ms

Communication via modem and telephone network is slowed considerably because of the transit time through the modems. A time-out of between 800–1000 ms is sufficient in most 38400 baud installations. In some cases, the poor quality of the telephone network may require a slower speed (9600 or 4800 bauds). The time-out value should then be increased (2–3 s), with the number of retries from 1–3.

Note: *The speed and parity of the calling modem must be configured in Windows with the same values as for SFT2841.*

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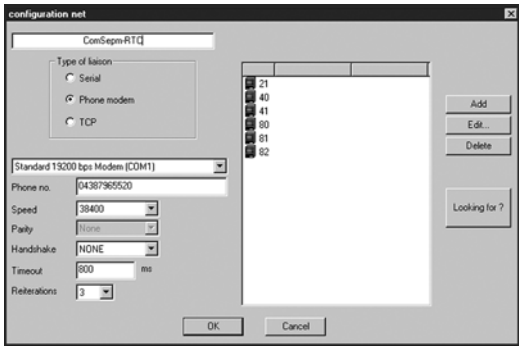
SFT2841 Setting and Operating Software
Configuration of a Sepam™ Network

PE50590



Configuration Window for the Communication network via Telephone Modem

Configuration of called Modem

The modem on the Sepam™ side is the called modem. Configure it via AT commands from a PC using HyperTerminal, the configuration tool that may have been supplied with the modem, or by setting switches (see the modem manufacturer's manual).

Modem RS485 Interface

In general, the configuration parameters for the modem's RS485 interface must be defined in accordance with the Sepam communication interface configuration:

- Speed:
  - 4800 Baud
  - 9600 Baud
  - 19200 Baud
  - 38400 Baud
- Character Format
  - 8 data bits + 1 stop bit + parity (none, even, odd)

Telephone Network Interface

Modern modems offer sophisticated features such as checking the quality of the telephone line, error correction and data compression. These options are not appropriate for communication between SFT2841 and Sepam, which is based on the Modbus RTU protocol. Their effect on communication performance may be the opposite of the expected result.

It is therefore highly advisable to:

- Disable the error correction, data compression, and telephone line quality monitoring options
- Use the same end-to-end communication speed between the:
  - Sepam network and the called modem
  - Called modem (Sepam side) and the calling modem (PC side)
  - PC and the calling modem (see recommended configurations table)

Sepam Network	Telephone Network	PC Modem Interface
38400 Baud	V34 modulation, 33600 Baud	38400 Baud
19200 Baud	V34 modulation, 19200 Baud	19200 Baud
9600 Baud	V32 modulation, 9600 Baud	9600 Baud

Industrial Configuration Profile

The following table shows the main characteristics of the modem on the Sepam side. These characteristics match a configuration profile commonly known as an "industrial profile", as opposed to the configuration of modems used in offices.

Characteristics of the "Industrial Profile" Configuration	AT Command
Transmission in buffered mode, without error correction	\N0 (force &Q6)
Data compression deactivated	%C0
Line quality monitoring deactivated	%E0
DTR signal assumed to be permanently off (allows the modem connection to be established automatically on an incoming call)	&D0
CD signal off when carrier is present	&C1
All reports made to Sepam blocked	Q1
Character echo suppression	E0
No flow control	&K0

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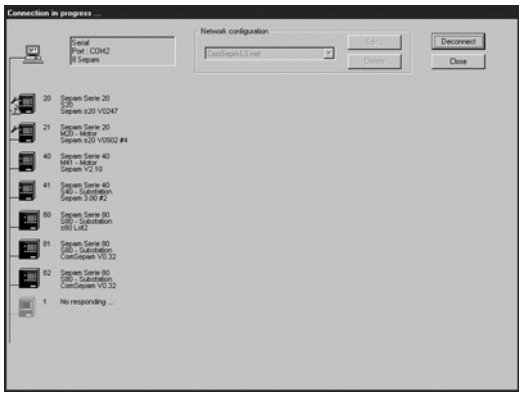
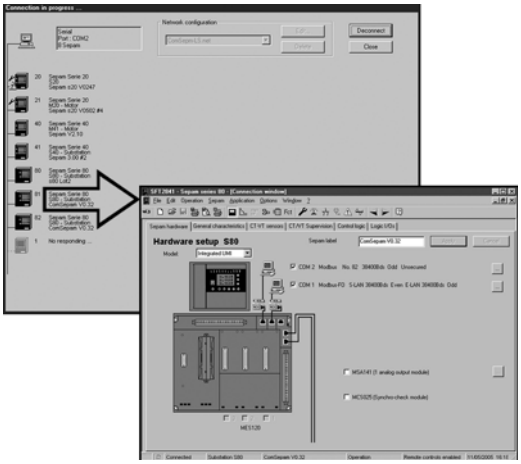
SFT2841 Setting and Operating Software
Configuration of a Sepam™ Network

PE50591



Sepam Network Connected to SFT2841

PE50592



Access to parameters and settings for a Sepam Series 80 Connected to a Communication Network

Identification of Sepam™ Units Connected to the Communication Network

The Sepam units connected to the communication network are identified by their Modbus address. These addresses can be configured in either of the following ways:

- Manually (one-by-one)
  - "Add" button is used to define a new Sepam device
    - It is allocated a default Modbus address
  - "Edit" button is used to modify the Modbus address if necessary
  - "Delete" button removes a device from the configuration
- Automatically (by running an automatic search of the Sepam units connected)
  - "Automatic search"/"Stop search" button starts or interrupts the search
  - When SFT2841 recognizes a Sepam unit, its Modbus address and type are shown on screen
  - When a Modbus device other than Sepam responds to SFT2841, its Modbus address is displayed. The text "???" indicates that the device is not a Sepam

The Sepam network configuration is saved in a file when the UMI window closes, by pressing the "OK" button.

Access to Sepam Information

To establish communication between SFT2841 and a Sepam network, select the Sepam network configuration you want, and press "Connect".
The Sepam network is displayed in the connection window. SFT2841 polls all the equipment defined in the selected configuration. Each Sepam queried is represented by an icon:

- Sepam Series 20 or Sepam Series 40 connected to the network
- Sepam Series 80 connected to the network
- Sepam configured but not connected to the network
- Device other than Sepam connected to the network.

A summary report of each Sepam detected as present is also displayed:

- Sepam Modbus address
- Type of application and Sepam identification
- Any alarms present
- Any minor/major faults present

To access parameters, settings, and operation and maintenance information for a particular Sepam relay, click on the icon for that Sepam. SFT2841 then establishes a point-to-point connection with the selected device.

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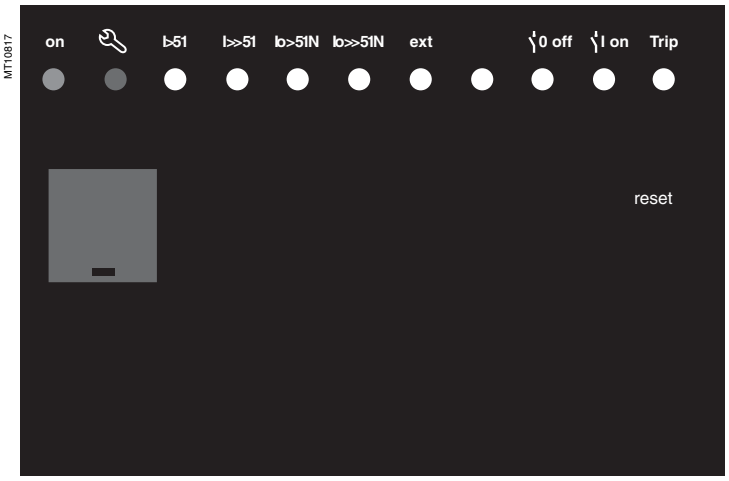
UMI on Front Panel
Presentation

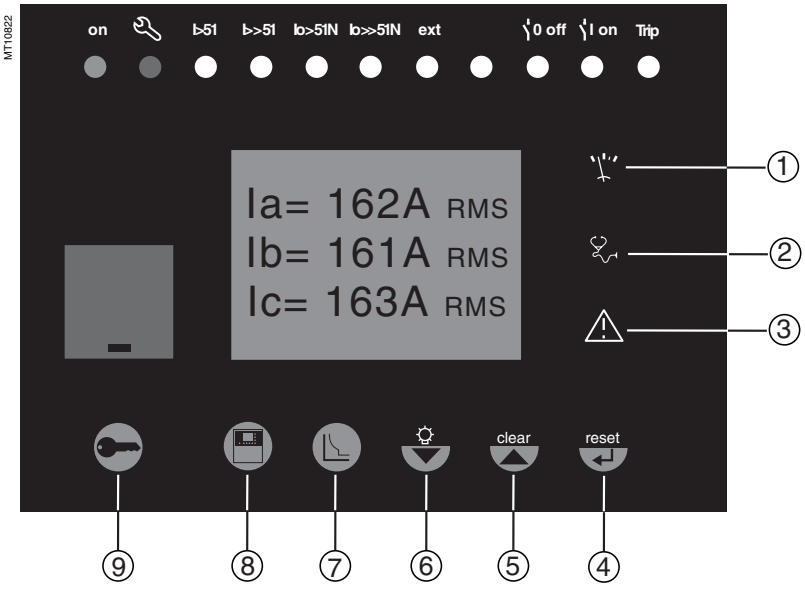
Basic UMI

This user-machine interface (UMI) includes:
- 2 LEDs indicating Sepam™ relay operating status:
  - Green "**on**" LED
    - Device on
  - Red LED: device unavailable
    - Initialization phase or detection of internal failure
- 9 Yellow LEDs (for custom parameters), with a standard label (with SFT2841, a customized label can be printed on a laser printer)
- Key for clearing faults and resetting
- 1 Connection port for the link with the PC (CCA783 cord)
  - The connector is protected by a sliding cover



Fixed or Remote Advanced UMI

In addition to the basic UMI functions, this version provides:
- **A "Graphic" LCD Display**
  - For the display of measurements, parameter/ protection settings, and alarm and operating messages
  - The number of lines, size of characters and symbols are in accordance with the screens and language versions
  - The LCD display retrolighting can be activated by pressing a key
- **A 9-Key Keypad with 2 Operating Modes**
  - White Keys for Current Operation:
    - ① Display of measurements
    - ② Display of "switchgear, network diagnosis" data
    - ③ Display of alarm messages
    - ④ Resetting
    - ⑤ Acknowledgment and clearing of alarms
  - Blue Keys Activated in Parameter and Protection Setting Mode:
    - ⑦ Access to protection settings
    - ⑧ Access to Sepam parameter settings including date and time (1)
    - ⑨ Used to enter the 2 passwords, required to change protection and parameter settings



The , , (④, ⑤, ⑥) keys are used to browse through the menus, and to scroll and accept the values displayed.

⑥ "**Lamp Test**" **Keys**:
switching on sequence of all the LEDs

(1) *Date/time saved in case the auxiliary power supply fails (< 24 hours).*

7

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Access to Measurements and Parameters

The measurements and parameters can be accessed using the metering, diagnosis, status and protection keys. They are arranged in a series of screens as shown in the diagram opposite.

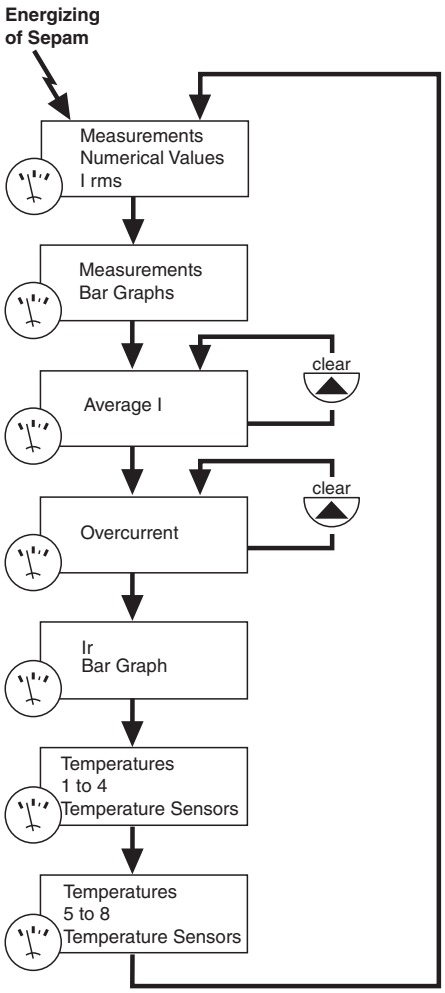
- The data are split up by category into 4 loops, associated with the following 4 keys:
  - Key : measurements
  - Key : switchgear diagnosis

  And additional measurements:
  - Key : general settings
  - Key : protection settings

- When the user presses a key, the system moves on to the next screen in the loop. When a screen includes more than 4 lines, the user can move about in the screen via the cursor keys (,).

Example: Measurement Loop

MT10885



Protection and Parameter Setting Modes

MT10808

There are 3 levels of use:

- Operator level
  - Used to access all the screens in read mode
  - Does not require any passwords
- Protection setting level
  - Requires the entry of the first password (key)
  - Allows protection setting (key)
- Parameter setting level
  - Requires the entry of the second password (key)
  - Allows modification of the general settings as well (key)

Only parameter setting level can modify the 4-digit passwords.

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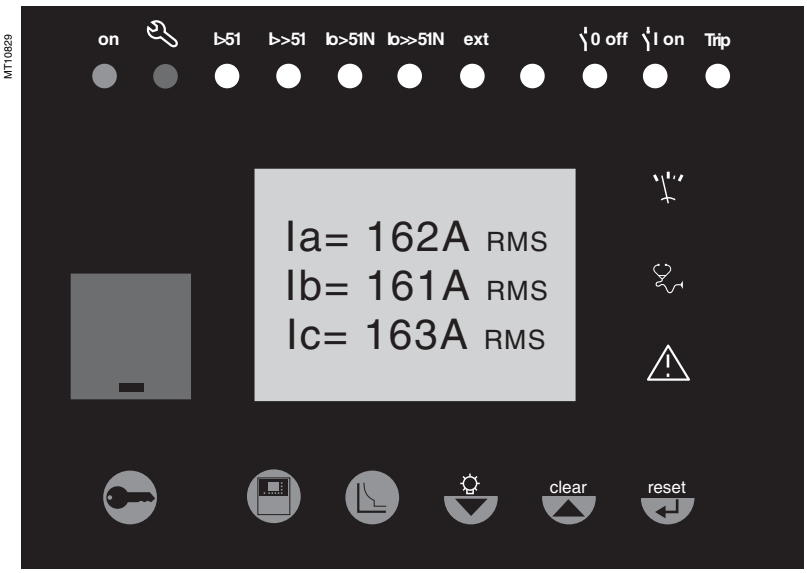
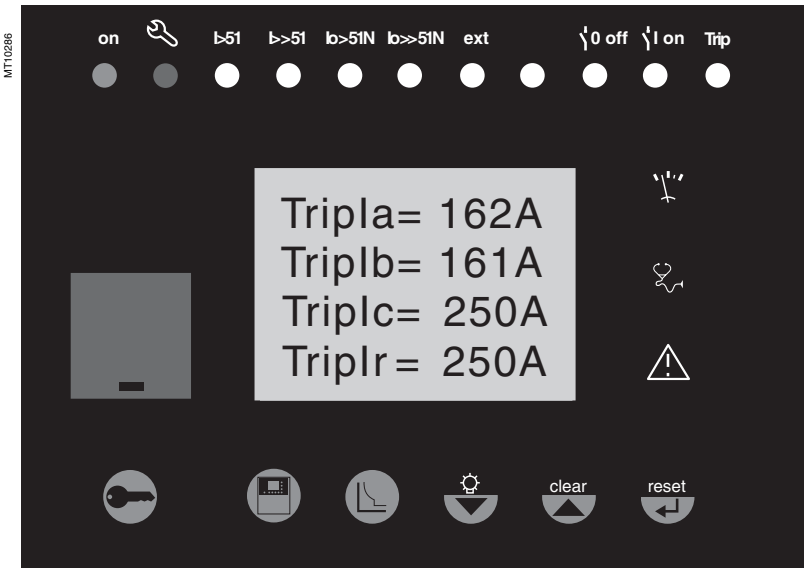
Key

The "metering" key is used to display the variables measured by the Sepam™ relay.



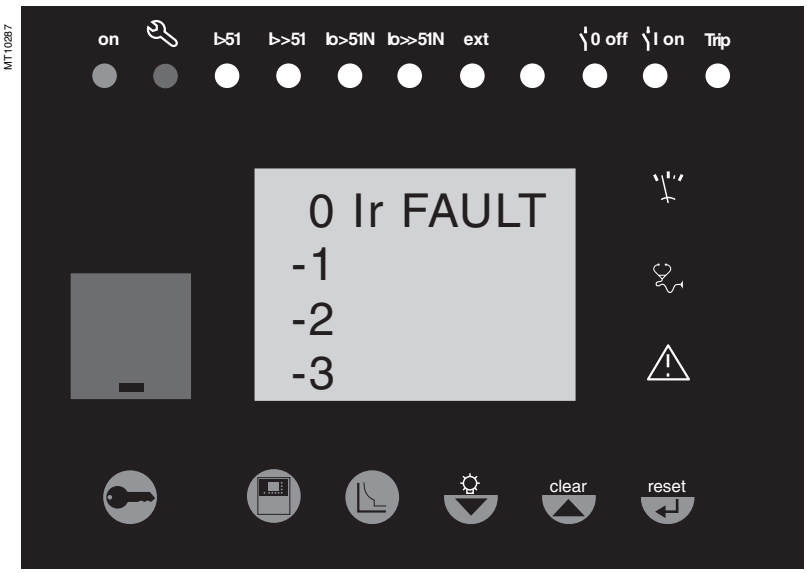
Key

The "diagnosis" key provides access to diagnostic data on the breaking device and additional measurements, to facilitate fault analysis.



Key

The "alarms" key is used to consult the 16 most recent alarms that have not yet been cleared.



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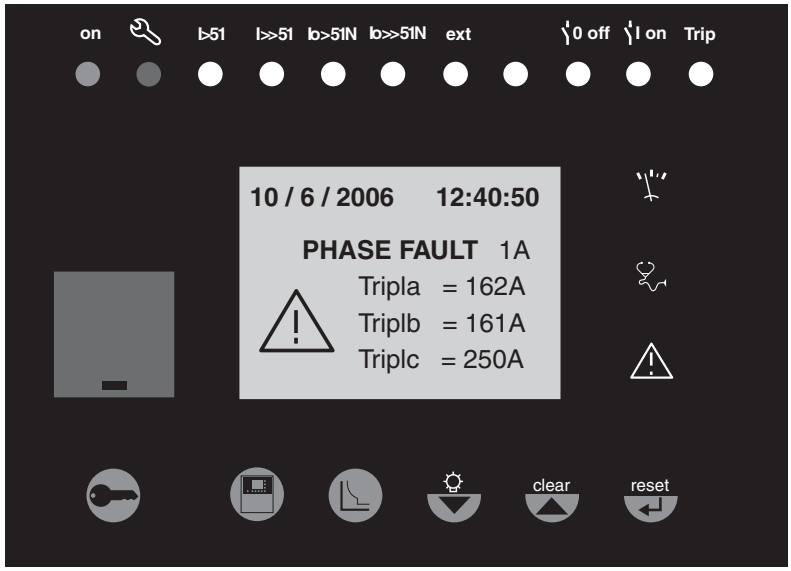
reset Key

The "reset" key resets the Sepam™ relay (switches off LEDs and restores the protection units to pre-fault conditions after the disappearance of faults).

The alarm messages are not erased.

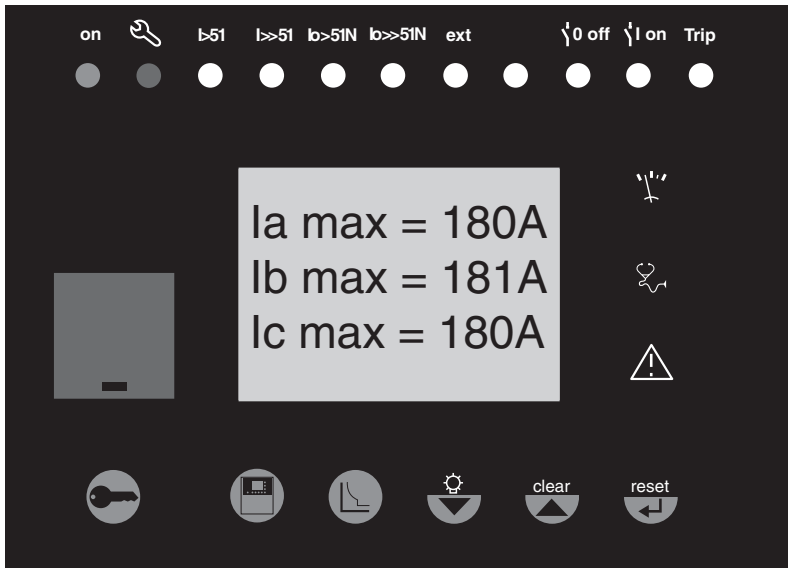


clear Key

When an alarm is present on the Sepam display, the "clear" key is used to return to the screen that was present prior to the appearance of the alarm or to a less recent unacknowledged alarm. This key does not reset the Sepam relay

.

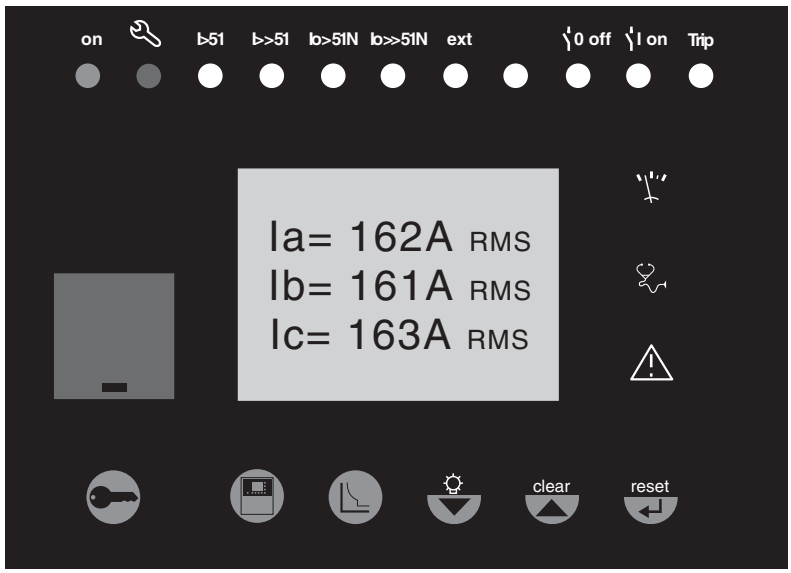
In the metering, diagnosis, or alarm menus the "clear" key can be used to reset the average currents, peak demand currents, running hours counter and alarm stack when they are shown on the display.



Key

Press the "lamp test" key for 5 seconds to start an LED and display test sequence.

Note: When an alarm is present, the "lamp test" key is disabled.



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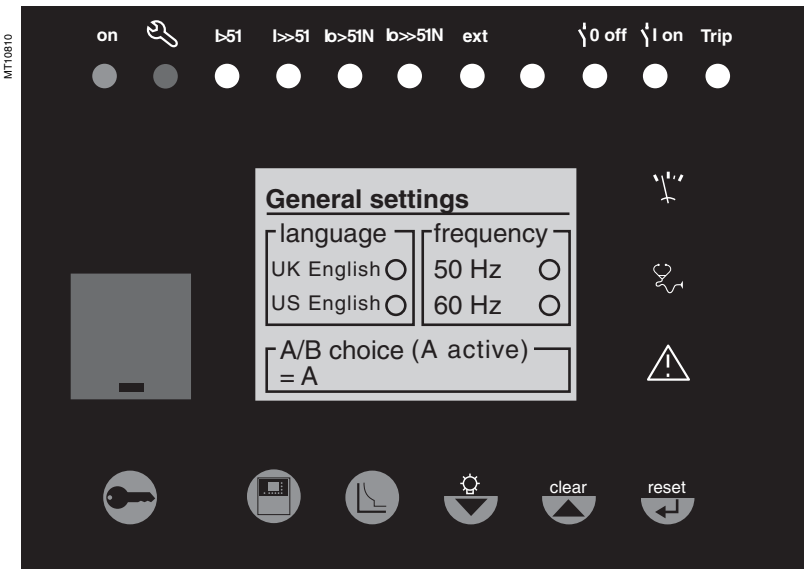
Advanced UMI
Blue Keys for Parameter and Protection Setting

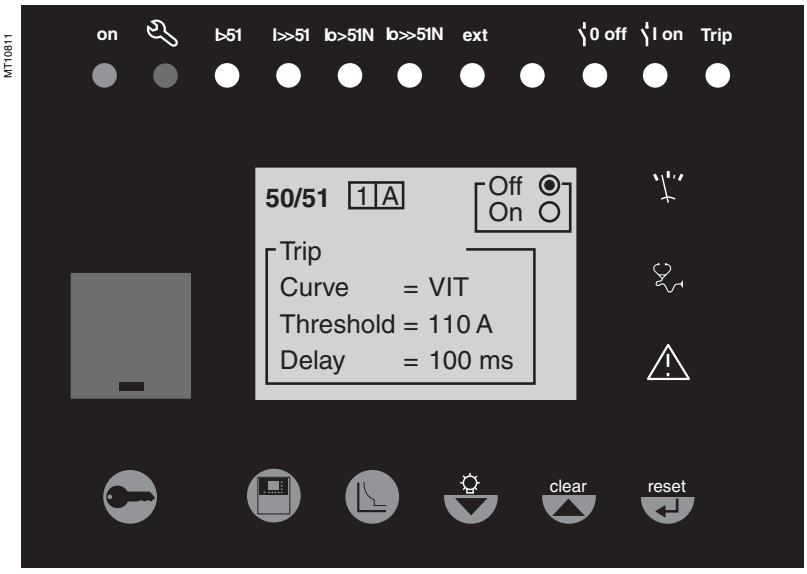
Key

The "status" key is used to display and enter the Sepam™ general settings including setting the Sepam date and time. They define the protected equipment characteristics and the different optional modules.



Key

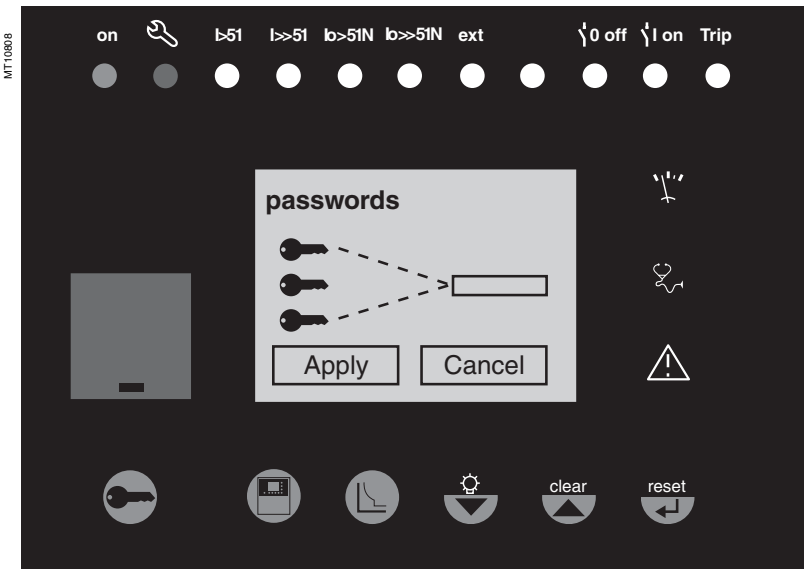
The "protection" key is used to display, set, and enable or disable the protection units.



Key

The "key" key is used to:

- Enter passwords for access to the different modes:
  - Protection setting
  - Parameter setting
- Return to "operating" mode (with no passwords)



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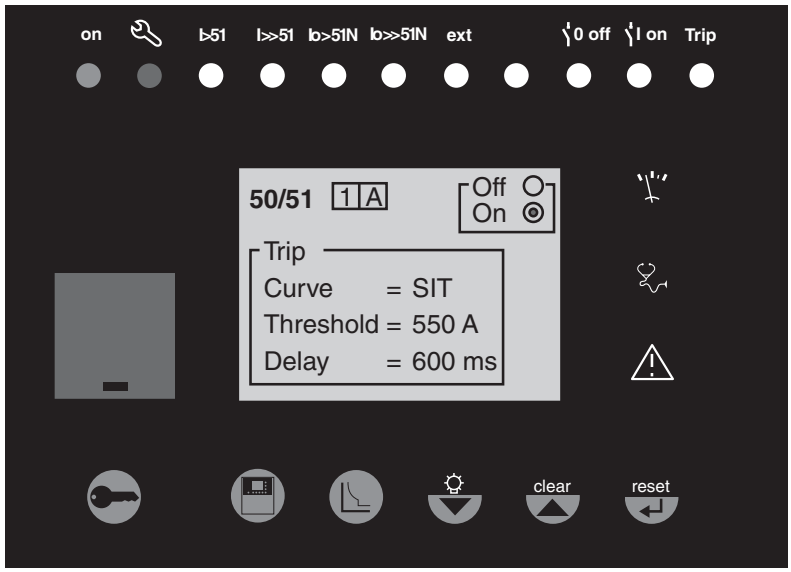
Advanced UMI
Blue Keys for Parameter and Protection Setting

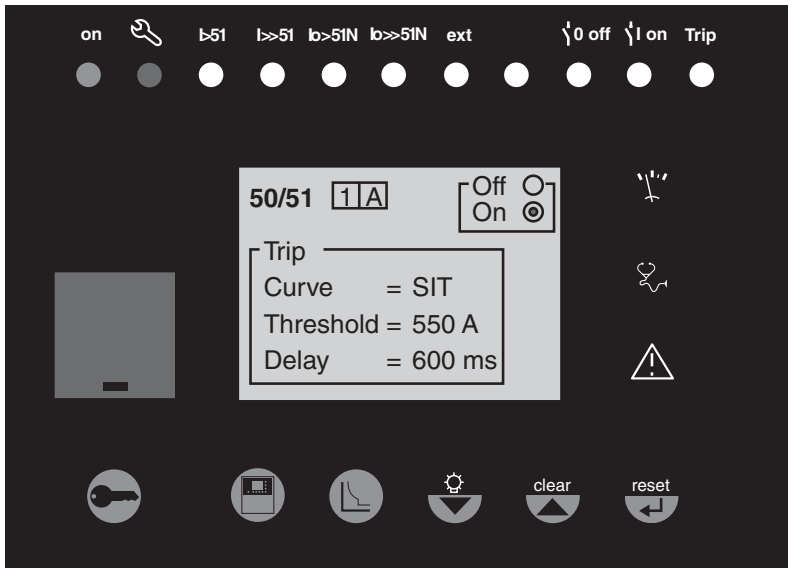
reset Key

The reset key is used to confirm the protection settings, parameter settings, and passwords.



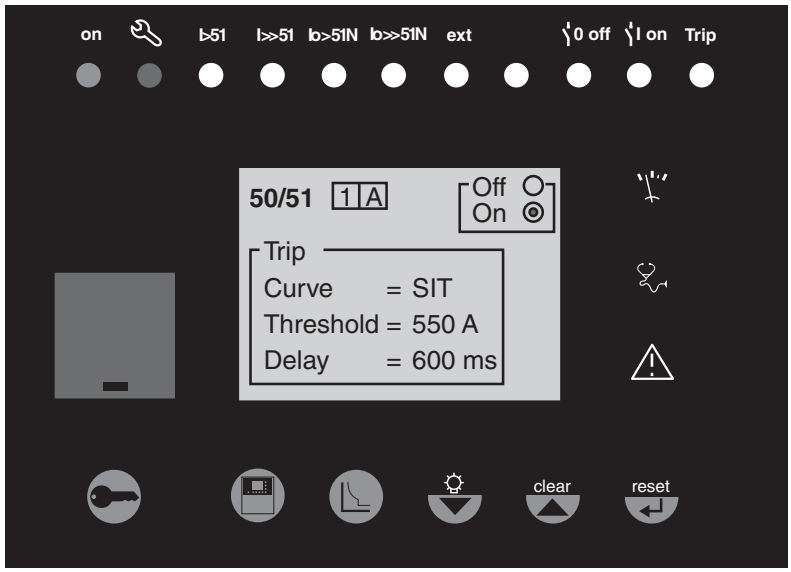
clear Key

When there are no alarms on the Sepam™ display and the user is in the status, protection, or alarm menus, the ▲ key is used to move the cursor upward.



Key

When there are no alarms on the Sepam display and the user is in the status, protection, or alarm menus, the ▼ key is used to move the cursor downward.



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Use of Passwords

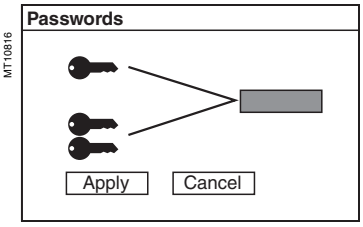
Sepam™ has two 4-digit passwords.

- The first password, symbolized by a key, is used to modify the protection settings
- The second password, symbolized by two keys, is used to modify the protection settings and all the general settings

The Factory-Set Passwords for both are "0000"

Entry of Passwords

Press the key to display the following screen:



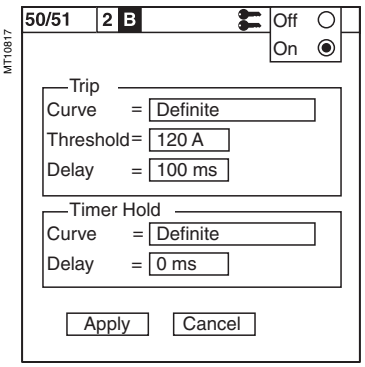
Press the key to position the cursor on the first digit 0|X|X|X

Scroll through the digits using the cursor keys (,) then confirm to go on to the next digit by pressing the key. Do not use characters other than numbers 0 to 9 for each of the 4 digits.

When the password for your qualification level is entered, press the key to position the cursor on the Apply box. Press the key again to confirm.

When Sepam is in protection setting mode, a key appears at the top of the display.

When Sepam is in parameter setting mode, two keys appear at the top of the display.



Access to the protection setting or parameter setting modes is disabled:

- By pressing the key
- Automatically if no keys are activated for more than 5 minutes

Modification of Passwords

Only the parameter setting qualification level (2 keys) or the SFT2841 allow modification of the passwords. Passwords are modified in the general settings screen, key.

Loss of Passwords

If the factory-set passwords have been modified and the latest passwords entered have been irretrievably lost by the user, please contact your local after-sales service representative.

Entry of Parameters or Settings

Principle Applicable to All Sepam Screens

(example of phase overcurrent protection)

- Enter the password
- Access the corresponding screen by successively pressing the key
- Move the cursor by pressing the key for access to the desired field (e.g. Curve)
- Press the key to confirm the choice, then select the type of curve by pressing the or key and confirm by pressing the key
- Press the key to reach the following fields, up to the Apply box. Press the key to confirm the setting

Entry of Numerical Values

(e.g., current threshold value)

- Position the cursor on the required field using the keys, then confirm to go on to the next digit by pressing the key
- Select the first digit to be entered and set the value by pressing the or key (choice of ___: 0……9)
- Press the key to confirm the choice and go on to the following digit.

The values are entered with 3 significant digits and a period.

The unit (e.g. A or kA) is chosen using the last digit.

- Press the key to confirm the entry, then press the key for access to the following field
- All of the values entered are only effective after the user confirms by selecting the Apply box at the bottom of the screen and presses the key

7

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Default Parameter Setting

The Sepam™ units are delivered with default parameter setting and protection setting according to the type of application. These "factory" settings are also used with the SFT 2841 software for:
- The creation of new files in disconnected mode
- A return to the "factory" settings in connected mode

S20, S23, T20, T23, M20 Applications

Hardware Configuration
- Identification
  - Sepam xxxx
- Model
  - UX (without fixed advanced UMI)
- MES module: Absent
- MET module: Absent
- MSA module: Absent
- DSM module: Present
- ACE module: Absent

Output Parameter Setting
- Outputs used: O1–O4
- N.O. Output Contacts: O1, O3
- N.C. Output Contacts: O2, O4
- Impulse mode: no (latched)

Program Logic
- Circuit Breaker Control: No
- Zone Selective Interlocking: No
- Logic Input Assignment: Not Used

General Characteristics
- Network Frequency: 50 Hz
- Group of Settings: A
- Enable Remote Setting: no
- Working Language: English
- CT Rating: 5 A
- Number of CTs: 3 (Ia, Ib, Ic)
- Rated Current In: 630 A
- Basic Current Ib: 630 A
- Integration Period: 5 min
- Residual Current: 3I sum
- Pre-trig for Disturbance Recording: 36 Cycles

Protection Functions
- All the protection functions are "Off"
- The settings comprise values and choices that are informative and consistent with the general default characteristics (in particular rated current IN)
- Tripping behavior
  - Latching: yes, except for functions 50BF, 49RMS, 37 and 66
  - Activation of output O1: yes, except for functions 50BF and 66
  - Disturbance recording triggering: except for functions 50BF, 48/51LR & 66

Control Matrix

Each Sepam has default program logic according to the type (S20, T20, etc.) as well as messages for the different LEDs. The functions are assigned according to the most frequent use of the unit. This parameter setting and/or marking can be customized if required using the SFT 2841 software tool.
- S20 application:
  - Activation of output O2 upon protection tripping
  - Activation of LEDs according to front panel markings
  - Watchdog on output O4
  - Disturbance recording triggering upon signal pick-up
- Additional functions for T20 application:
  - Activation of O1 without latching upon tripping of temperature monitoring 1 to 7
  - Activation of O1 and LED L9 without latching upon thermal overload tripping
- Additional functions for M20 application:
  - Activation of outputs O1 and O2 and LED L9 upon tripping of functions, 37 (phase undercurrent) and 51LR (locked rotor)
  - Activation of output O2 upon tripping of function 66 (starts per hour)
  - Latching for function 51LR
- Complement for S23, T23 applications:
  - All functions, except for 49 RMS, activate the 50BF protection function in the absence of circuit breaker control

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B21[1] and B22 Applications

Hardware configuration
- Identification: Sepam™ xxxx
- Model: UX (without fixed advanced UMI)
- MES module: Absent
- MET module: Absent
- MSA module: Absent
- DSM module: Present
- ACE module: Absent

Output Parameter Setting
- Outputs used: O1–O4
- N.O. Output Contacts: O1–O3
- N.C. Output Contacts: O4
- Impulse mode: No (Latched)

Program Logic
- Circuit breaker control: No
- Logic input assignment: Not used

General Characteristics
- Network frequency: 50 Hz
- Enable remote setting: No
- Working language: English
- Primary rated voltage ($V_{LL}p$): 20 kV
- Secondary rated voltage ($V_{LL}s$): 100 V
- Voltages measured by VTs: Van, Vbn, Vcn
- Residual voltage: sum of 3Vs
- Pre-trig for disturbance recording: 36 Cycles

Protection Functions
- All the protections are "Off"
- The settings comprise values and choices that are informative and consistent with the general characteristics by default
- Latching: no
- Disturbance recording triggering: with

Control Matrix
- Assignment of output relays and LEDs according to chart:

Functions		Outputs				LEDs								
B21	B22	O1	O2	O3	O4	L1	L2	L3	L4	L5	L6	L7	L8	L9
27D-1	27D-1		■				■							
27D-2	27D-2	■					■							■
27R	27R			■				■						
27-1	27-1		■			■								
27-2	27-2	■				■								■
27S-1	27S-1	■				■								■
27S-2	27S-2	■				■								■
27S-3	27S-3	■				■								■
59-1	59-1		■						■					
59-2	59-2	■							■					■
59N-1	59N-1		■							■				
59N-2	59N-2	■								■				■
81H	81H	■									■			■
81L-1	81L-1		■									■		
81L-2	81L-2	■											■	■
	81R	■											■	■

- Disturbance recording triggering upon signal pick-up
- Watchdog on output O4

LED Marking
L1: V < 27
L2: V < 27D
L3: V < 27R
L4: V > 59
L5: V > 59N
L6: F > 81H
L7: F < 81L
L8: F << 81L
L9: Trip

(1) Type B21 performs the same functions as cancelled type B20.

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Commissioning: Principles and Method

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should commission this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Obey all existing safety instructions when commissioning and maintaining high-voltage equipment.
- Beware of potential hazards and wear personal protective equipment.

Failure to follow these instructions will result in death or serious injury.

Protection Relay Testing

Protection relays are tested prior to commissioning, with the dual aim of maximizing availability and minimizing the risk of malfunction of the assembly being commissioned. The problem consists of defining the consistency of the appropriate tests, keeping in mind that the relay is always involved as the main link in the protection chain.

Therefore, protection relays based on electromechanical and solid state technologies must be systematically submitted to detailed testing, not only to qualify relay commissioning, but also to check that they actually are in good operating order and have the required level of performance.

The Sepam™ Concept Makes It Possible to do Away With Such Testing.

- Use of digital technology ensures the reproducibility of the stated performances
- Each of the Sepam functions has undergone full factory qualification
- An internal self-testing system provides continuous information on the state of the electronic components and the integrity of the functions (e.g. automatic tests diagnose the level of component polarization voltages, the continuity of the analog value acquisition chain, non-alteration of RAM memory, absence of settings outside the tolerance range) and thereby ensures a high level of availability

Therefore, Sepam relays are ready to operate without any additional qualification testing that directly concerns them.

Sepam Commissioning Tests

The preliminary Sepam commissioning tests can be limited to a commissioning check, i.e.:

- Checking compliance with BOMs and hardware installation diagrams and rules during a preliminary general check
- Checking compliance of the general settings and protection settings entered with the setting sheets
- Checking current or voltage input connections by secondary injection tests
- Checking logic input and output connections by simulation of input data and forcing of output status
- Validating the complete protection chain
- Checking the connection of the optional MET1482 and MSA141 modules.

The various checks are described further on

General Principles

- All the tests should be carried out with the MV cubicle completely isolated and the MV circuit breaker racked out (disconnected and open)
- All the tests are to be performed under operating conditions: no wiring or setting changes, even temporary changes to facilitate testing, are allowed.
- The SFT2841 parameter setting and operating software is the basic tool for all Sepam users. It is especially useful during Sepam commissioning tests.
  - Tests described in this document are based on the use of that tool
  - The commissioning tests can be performed without the SFT2841 software for Sepam units with advanced UMIs

Method

For each Sepam:

- Only carry out the checks suited to the hardware configuration and the functions activated
- Use the test sheet provided to record the results of the commissioning tests

A comprehensive description of all the tests is given further on:

- Checking phase current input connections
  - With 1 A/5 A transformer, see p7/25
  - With LPCT type current sensor, see p 7/26
- Checking the residual current input connection, see p7/27
- Checking phase voltage input connections, see p7/28
- Checking the residual voltage input connection, see p7/29

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Testing and Metering Equipment Required

Generators

- Sinusoidal AC current generator
  - 50 or 60 Hz frequency (according to the country)
  - Single-phase type, adjustable from 0 to 50 Arms
  - With connector suited to the built-in test terminal box in the current input connection diagram
- Sinusoidal AC voltage generator
  - 50 or 60 Hz frequency (according to the country)
  - Single-phase type, adjustable from 0 to 150 Vrms
  - With connector suited to the built-in test terminal box in the voltage input connection diagram
- DC voltage generator
  - Adjustable from 24–250 V DC
  - For adaptation to the voltage level of the input being tested
  - With electric cord and clamps, wire grip or touch probes

Metering Devices

- 1 ammeter, 0 to 50 Arms
- 1 voltmeter, 0 to 150 Vrms

Computer Equipment

- PC with minimum configuration
  - Microsoft Windows 98/XP/2000/NT 4.0
  - 133 MHz Pentium processor
  - 64 MB of RAM (or 32 MB with Windows 98)
  - 64 MB free on hard disk
  - CD-ROM drive
- SFT2841 software
- CCA783 serial connection cord between the PC and the Sepam™ relay

Documents

- Complete connection diagram of Sepam and additional modules, with:
  - Phase current input connection to corresponding CTs via the test terminal box
  - Residual current input connection
  - Phase voltage input connection to corresponding VTs via the test terminal box
  - Residual voltage input connection to corresponding VTs via the test terminal box
  - Logic input and output connection
  - Temperature sensor connection
  - Analog output connection
- Hardware BOMs and installation rules
- All Sepam parameter and protection settings, available in paper format

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General Examination and Preliminary Actions

Checking to Be Done Prior to Energizing

Apart from the mechanical state of the equipment, use the diagrams and BOMs provided by the contractor to check:

- Identification of Sepam™ relay and accessories defined by the contractor
- Correct grounding of Sepam (via terminal 17 of the 20-pin connector)
- Conformity of Sepam auxiliary voltage (indicated on the label stuck to the right side of the base unit) with the auxiliary supply voltage of the switchboard (or cubicle)
- Correct connection of the auxiliary voltage:
  - □ Terminal 1: AC or positive polarity
  - □ Terminal 2: AC or negative polarity
- Presence of a residual current measurement zero sequence CT and/or additional modules connected to Sepam, when applicable
- Presence of test terminal boxes upstream from current inputs and voltage inputs
- Conformity of connections between Sepam terminals and the test terminal boxes

Connections

Check that the connections are tightened (with equipment not energized). The Sepam connectors must be correctly plugged in and locked.

Energizing

1 Switch on the auxiliary power supply.
2 Check that Sepam performs the following initialization sequence, which lasts approximately 6 seconds:
- □ Green ON and red LEDs on
- □ Red LED off
- □ Pickup of "watchdog" contact

The first screen displayed is the phase current or phase voltage metering screen according to the application.

Implementation of the SFT2841 Software for PC

1 Start up the PC.
2 Connect the PC RS232 serial port to the communication port on the front panel of Sepam using the CCA783 cord.
3 Start up the SFT2841 software, by clicking on the related icon.
4 Choose to connect to the Sepam to be checked.

Identification of Sepam

1 Note Sepam serial number on label placed on the right side of the base unit.
2 Note the Sepam type and software version using the SFT2841 software, "Sepam Diagnosis" screen. (This information is also available on the advanced UMI, in the Sepam general settings).
3 Record these numbers on the test sheet.

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Checking Parameter and Protection Settings

Determination of Parameter and Protection Settings

All of the Sepam™ parameter and protection settings are determined beforehand by the design department in charge of the application, and should be approved by the customer. It is presumed that the study has been carried out with all the attention necessary, or even consolidated by a network coordination study.

All of the Sepam parameter/protection settings should be available at the time of commissioning:

- In hard copy format (using the SFT2841 software, the "parameter and protection setting" file for a Sepam relay can be printed or exported to a text file for editing)
- When applicable, in the format of a file to be downloaded into Sepam using the SFT2841 software

Checking Parameters and Protection Settings

A check is necessary to confirm whether the Sepam parameter and protection settings have been entered or downloaded during commissioning testing, and to confirm the conformity of the parameter and protection settings entered with the values determined during the study (the aim of this check is not to confirm the relevance of the parameter and protection settings).

1. Go through all the parameter and protection setting screens in the SFT2841 software, in the order proposed in guided mode.
2. For each screen, compare the values entered in the Sepam with the values recorded in the parameter and protection setting file.
3. Correct any parameter and protection settings that have not been entered correctly, proceeding as indicated in the "Use of the (SFT2841) software" section of this manual.

Conclusion

Once the checking has been performed and proven conclusive, as of that phase, the parameter and protection settings should not be changed any further and are considered to be final.

In order to be conclusive, the tests which follow must be performed with these parameter and protection settings; no temporary modification of any of the values entered, with the aim of facilitating a test, is permissible.

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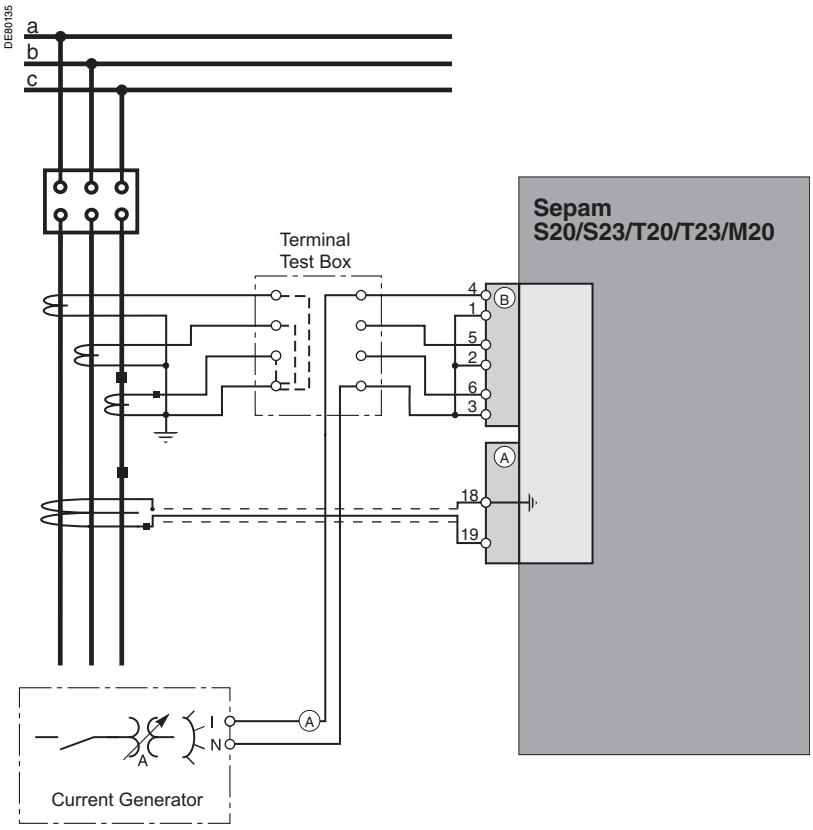
Checking Phase Current Input Connections
1 A/5 A Current Transformers

Description
Analysis to be carried out for Sepam™ S20, S23, T20, T23 or M20, when phase currents are measured by 1 A or 5 A current transformers.

Procedure
1 To inject a current into the phase 1 input, connect the single-phase generator to the test terminal box using the plug provided, in accordance with the diagram below:



2 Turn on the generator.
3 Inject the CT secondary rated current, i.e. 1 A or 5 A.
4 Use the SFT2841 software to check that the phase 1 current value is approximately equal to the CT primary rated current.
5 If the residual current is calculated by taking the sum of the 3 phase currents, use the SFT2841 software to check that the residual current value is approximately equal to the CT primary rated current.
6 If the residual current is measured via 3 phase CTs, use the SFT2841 software to check that the residual current value is approximately equal to the CT primary rated current.
7 Turn off the generator.
8 Proceed in the same way for the other 2 phase current inputs.
9 At the end of the test, put the cover back on the test terminal box.

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Checking Phase Current Input Connections
LPCT Type Current Sensors

Description
Check to be performed for Sepam™ S20, S23, T20, T23 or M20, when phase currents are measured by LPCT-type current sensors.

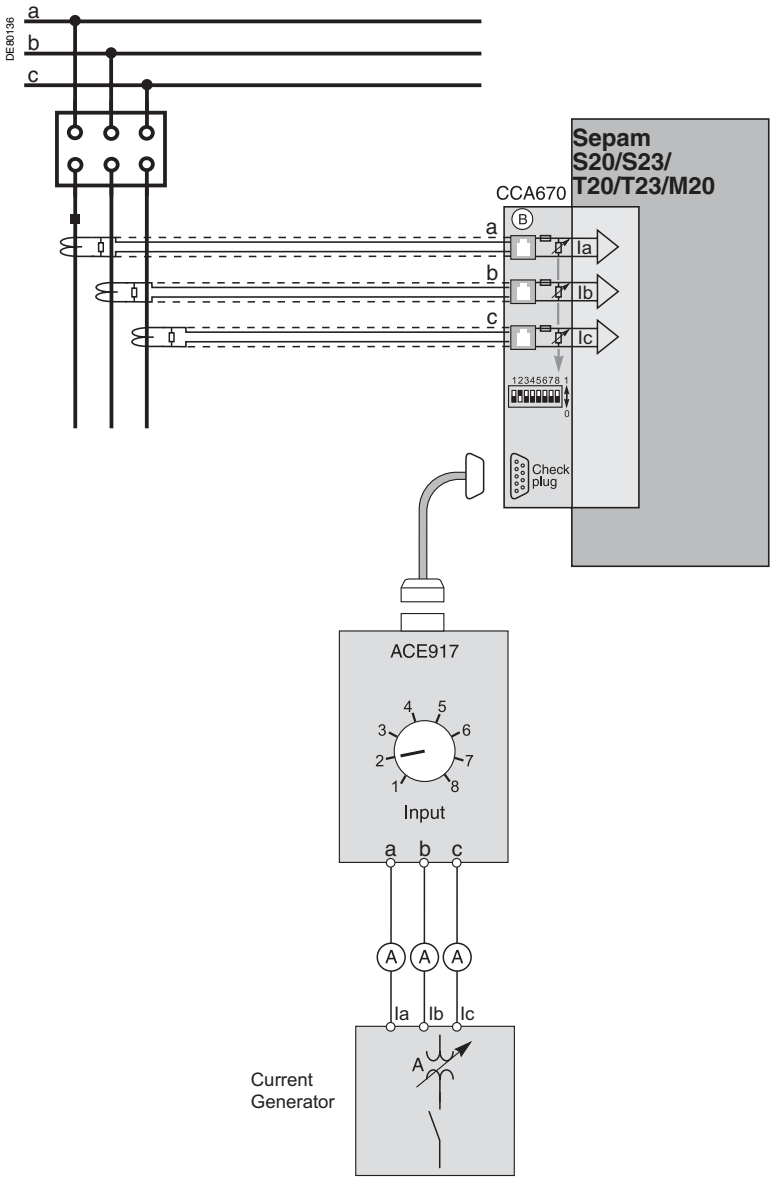
Phase Current Measurement by LPCT sensors
- The 3 LPCT current sensors are connected via an RJ45 plug to the CCA670 connector which is to be mounted on the rear panel of Sepam, identified as (B)
- The connection of only one or two LPCT sensors is not allowed and causes Sepam to go into the fail-safe position
- The primary rated current In measured by the LPCT sensors is to be entered as a Sepam general setting and configured by microswitches on the CCA670 connector.

Procedure
The tests to be carried out to check phase current input connections are the same whether the phase currents are measured by CTs or by LPCT sensors. Only the Sepam current input connection procedure and current injection values change.

To test current inputs connected to LPCT sensors with a standard injection box, the ACE917 injection adapter is required. The ACE917 adapter is inserted between:
- The standard injection box
- The LPCT test plug
  - Integrated in the Sepam CCA670 connector
  - Transferred by means of the CCA613 accessory

The ACE917 injection adapter should be set according to the currents selected on the CCA670 connector: the ACE917 setting should be equal to the number of the microswitch that is set to 1 on the CCA670. The injection value depends on the primary rated current selected on the CCA670 connector and entered in the Sepam general settings:
- 1 A for the following values (in Amps): 25, 50, 100, 133, 200, 320, 400, 630
- 5 A for the following values (in Amps): 125, 250, 500, 666, 1000, 1600, 2000, 3150

Block Diagram (Without CCA613 Accessory)



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Checking the Residual Current Input Connection

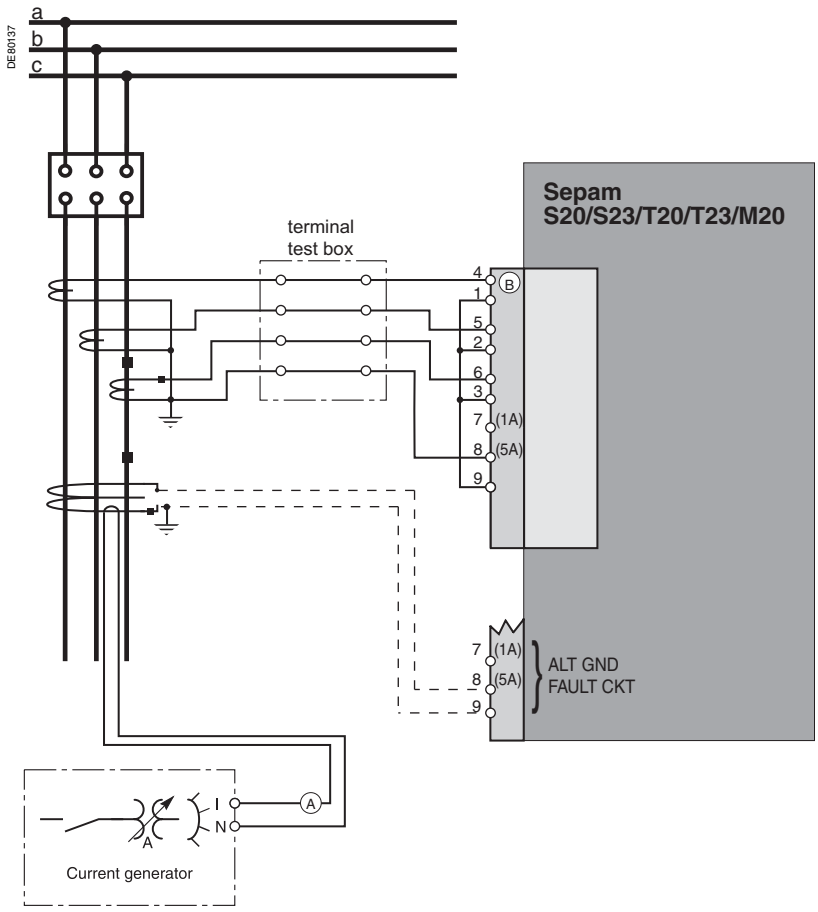
Description

Check to be carried out for Sepam™ S20, S23, T20, T23 or M20, when the residual current is measured by a specific sensor:

- CSH120 or CSH200 zero sequence CT
- Another zero sequence CT connected to an ACE990 interface
- A single 1 A or 5 A CT encompassing the 3 phases

Procedure

1 Connect the single-phase current generator to inject current into the primary circuit of the zero sequence CT or the CT, in accordance with the diagram below:



2 Turn on the generator.
3 Inject a 5 A primary residual current.
4 Use the SFT2841 software to check that the residual current value is approximately equal to 5 A.
5 Turn off the generator.

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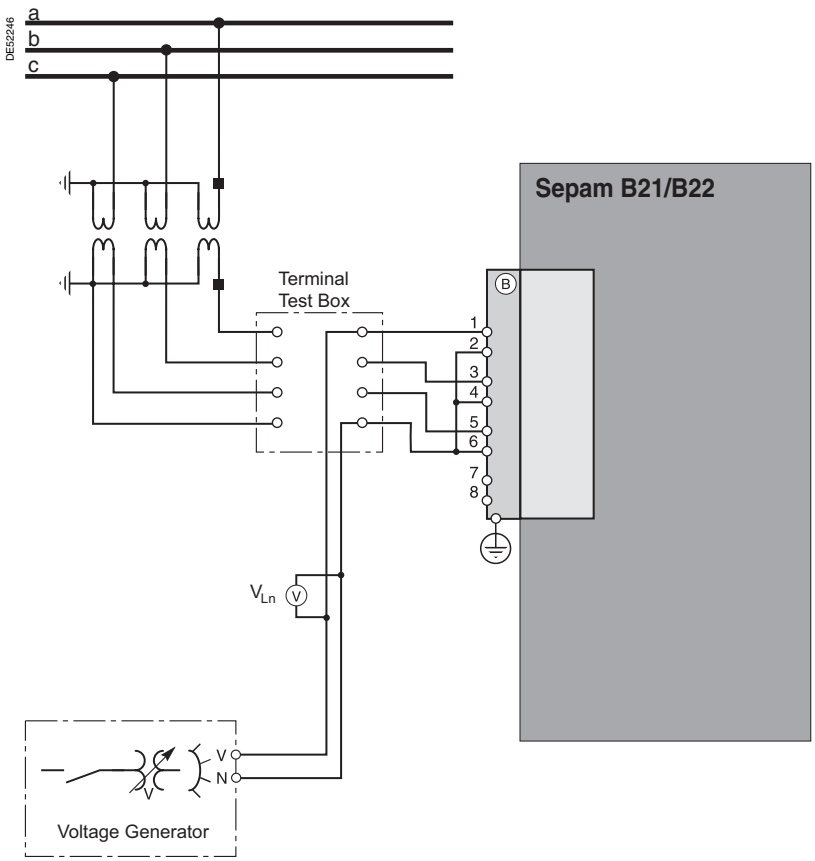
Checking Phase Voltage Input Connections

Description

Check to be carried out for Sepam™ B21 or B22.

Procedure

1 To apply a phase-to-neutral voltage to the phase 1 voltage input, connect the single-phase voltage generator to the test terminal box using the plug provided, in accordance with the diagram below:



2 Turn on the generator.
3 Apply the VT secondary rated phase-to-neutral voltage ($V_{LL}s/\sqrt{3}$).
4 Use the SFT2841 software to check that the phase-to-neutral voltage V1 is equal to the VT primary rated phase-to-neutral voltage ($V_{LL}p/\sqrt{3}$).
5 If the residual voltage is calculated by taking the sum of the 3 voltages, use the SFT2841 software to check that the residual voltage value is approximately equal to the VT primary rated phase-to-neutral voltage ($V_{LL}p/\sqrt{3}$).
6 Turn off the generator.
7 Proceed in the same way for the other 2 phase voltage inputs.
8 At the end of the test, put the cover back on the test terminal box.

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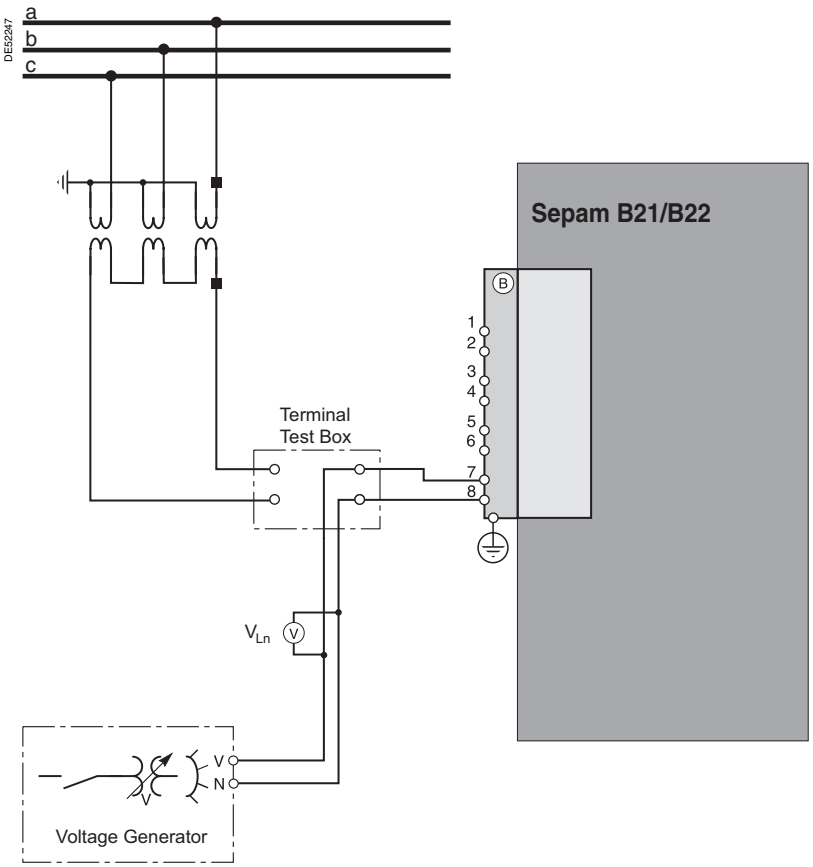
Checking the Residual Voltage Input Connection

Description

Check to be carried out for Sepam™ B21 or B22, when the residual voltage is measured by 3 VTs on the secondary circuits connected in an open delta arrangement.

Procedure

1 Connect the single-phase voltage generator to the test terminal box using the plug provided, in accordance with the diagram below:



2 Turn on the generator.
3 Apply the VT secondary rated phase-to-neutral voltage ($V_{LL}s/\sqrt{3}$).
4 Use the SFT2841 software to check the residual voltage value Vr.
5 Vr should be equal to the VT primary rated phase-to-neutral voltage ($V_{LL}p/\sqrt{3}$ or $V_{Ln}p$) if the VTs deliver $V_{LL}s/\sqrt{3}$ to the secondary circuit.
6 Vr should be equal to the VT primary rated phase-to-phase voltage ($V_{LL}p$ or $\sqrt{3}\,V_{Ln}p$) if the VTs deliver $V_{LL}s/3$ to the secondary circuit.
7 Turn off the generator.
8 Put the cover back on the test terminal box.

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Checking Logic Input and Output Connections

MT10588

SFT2841 "Input, output, indicator status" screen

Checking Logic Input Connections

Procedure

Proceed as follows for each input:

1 **If the input supply voltage is present**, use an electric cord to short-circuit the contact that delivers logic data to the input.

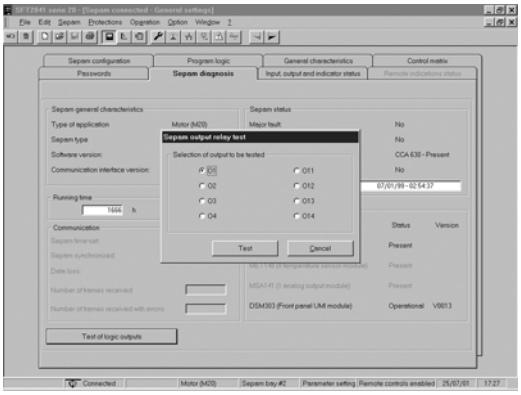
2 **If the input supply voltage is not present**, apply a voltage supplied by the DC voltage generator to the terminal of the contact linked to the chosen input, being sure to comply with the suitable polarity and level.

Note: *Step 2 is not valid if the MET114E/F is set for Vac input.*

3 **Observe the change of status of the input** using the SFT2841 software, in the "Input, output, indicator status" screen.

4 At the end of the test, if necessary, press the SFT2841 "Reset" key to clear all messages and deactivate all outputs.

MT10589



SFT2841 "Sepam Diagnosis - output relay test" screen

Checking Logic Output Connections

Procedure

Test carried out using the "Output relay test" function, activated via the SFT2841 software, in the "Sepam™ Diagnosis" screen. Only output O4, when used for the watchdog, can be tested. This function requires prior entry of the "Parameter setting" password.

1 Activate each output relay using the buttons in the SFT2841 software.

2 The activated output relay changes status over a period of 5 seconds.

3 Observe the change of status of the output relay through the operation of the related switchgear (if it is ready to operate and is powered), or connect a voltmeter to the terminals of the output contact (the voltage cancels itself out when the contact closes).

4 At the end of the test, if necessary, press the SFT2841 Reset key to clear all messages and deactivate all outputs.

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Validation of the Complete Protection Chain

Principle

The complete protection chain is validated during the simulation of a fault that causes tripping of the breaking device by the Sepam™ relay.

Procedure

1 Select one of the protection functions that trips the breaking device.
2 According to the type of Sepam device, inject a fault current or voltage.
3 Observe the tripping of the breaking device.

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Checking Optional Module Connections

Checking Temperature Sensor Input Connections to the MET1482 Module

The temperature monitoring function provided by Sepam™ T20, T23 or M20 units checks the connection of each sensor that is configured. An "RTD FAULT" alarm is generated whenever one of the sensors is detected as being short-circuited or disconnected (absent). To identify the faulty sensor or sensors:

1 Display the temperature values measured by Sepam T20 or M20 using the SFT2841 software.

2 Check the consistency of the temperatures measured:

- □ The temperature displayed is "****" if the sensor is short-circuited
  T < -31° F (T < -35° C)
- □ The temperature displayed is "-****" if the sensor is disconnected
  T > 401° F (T > 205° C)

Checking the Analog Output Connection to the MSA141 Module

1 Identify the measurement associated by parameter setting with the analog output using the SFT2841 software.

2 Simulate, if necessary, the measurement linked to the analog output by injection.

3 Check the consistency between the value measured by Sepam and the indication given by the device connected to the analog output.

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Test Sheet
Sepam™ Series 20

Project: ..... **Type of Sepam** ☐☐☐

Switchboard: ..... **Serial Number** ☐☐☐☐☐☐☐☐☐

Cubicle: ..... **Software Version** V☐☐☐☐☐

Overall Checks

Check the box v when the check has been made and is conclusive

Type of Check	
Preliminary General Examination, Prior to Energizing	☐
Energizing	☐
Parameter and Protection Settings	☐
Logic Input Connection	☐
Logic Output Connection	☐
Validation of the Complete Protection Chain	☐
Analog Output Connection to the MSA141 Module	☐
Temperature Sensor Input Connection to the MET1482 Module (for Type T20, T23 or M20)	☐

Checking of Sepam S20, S23, T20, T23 or M20 Current Inputs

Type of Check	Test Performed	Result	Display	
Phase Current Input Connection	Secondary Injection of CT Rated Current, i.e. 1 A or 5 A	CT rated primary current	Ia =..... Ib =..... Ic =.....	☐
Residual Current Value Obtained by 3-Phase CT	Secondary Injection of CT Rated Current, i.e. 1 A or 5 A	CT Rated Primary Current	Ir =.....	☐
Residual Current Input Connection to a Specific Sensor: ■ **CSH120 or CSH200** ■ **Other Zero Sequence CT + ACE990** ■ **1 x 1 A or 5 A CT**	Injection of 5 A into Primary Circuit of Zero Sequence CT or CT	Injected Current Value	Ir =.....	☐

Checking of Sepam B21 or B22 Voltage Inputs

Type of Check	Test Performed	Result	Display	
Phase Voltage Input Connection	Secondary Injection of VT Rated Phase-to-Neutral Voltage $V_{LL}s/\sqrt{3}$	VT Primary Rated Phase-to-Neutral Voltage $V_{LL}p/\sqrt{3}$	Van = ... Vbn = ... Vcn =.....	☐
Residual Voltage Value Obtained by 3-phase VT	Secondary Injection of VT Rated Phase-to-Neutral voltage $V_{LL}s/\sqrt{3}$	VT Primary Rated Phase-to-Neutral Voltage $V_{LL}p/\sqrt{3}$	Vr = ...	☐
Residual Roltage Input Connection	**Secondary Injection of Voltage $V_{LL}s/\sqrt{3}$**	**Residual Voltage = $V_{LL}p/\sqrt{3}$ (if $V_{LL}s/\sqrt{3}$ VT) = $V_{LL}p$ (if $V_{LL}s/3$ VT)**	Vr = ...	☐

Tests Performed On: .....
By: .....

Signatures

Comments:
.....
.....

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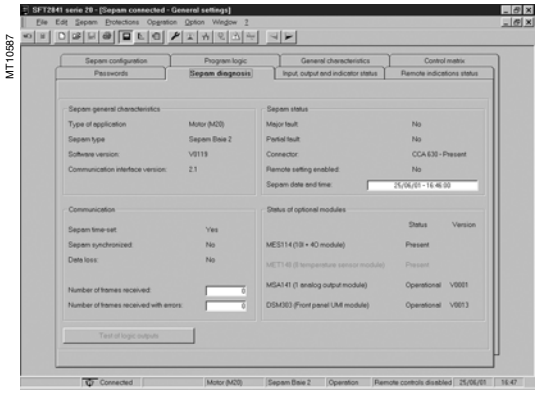
Maintenance

Sepam™ has a large number of self-tests that are carried out in the base unit and in additional modules. These tests exist to:
- Detect failures that can lead to nuisance tripping or the failure to trip when a fault occurs
- Put Sepam in the fail-safe position to avoid user errors
- Notify the operator that a maintenance operation is required

The "Sepam Diagnosis" screen of the SFT2841 software provides access to data on the status of the base unit and optional modules.


MT10587

SFT2841 "Sepam Diagnosis" Screen

Shutdown of the Base Unit in Fail-Safe Position

The base unit goes into the fail-safe position in the following conditions:
- Detection of an internal failure by the self-tests
- Sensor interface connector missing (CCA630, CCA634, CCA670 or CCT640 according to the type of application)
- No connection of one of the 3 LPCT sensors to the CCA670 (connectors L1, L2, L3)
- MES module configured but missing.

The fail-safe position is conveyed by:
- ON LED on
- LED on the base unit steadily on
- O4 "watchdog" relay in fault position
- Output relays dropped out
- All protection units blocked
- Display showing fault message

- LED on DSM303 module (remote advanced UMI option) flashing.

Downgraded Operation

The base unit is in working order (all the protection functions activated are operational) and indicates that one of the optional modules such as DSM303, MET1482 or MSA141 is faulty or else that a module is configured but not connected. According to the model, this operating mode is conveyed by:
- Sepam with integrated advanced UMI (UD base)
  - ON LED on
  - LED on the base unit flashing, including when the display is out of order (off)
  - LED on the MET or MSA module faulty, steadily on.
- The display shows a partial fault message and indicates the type of fault by a code
  - Code 1: inter-module link fault
  - Code 3: MET module unavailable
  - Code 4: MSA module unavailable.
- Sepam with remote advanced UMI, UX base + DSM303
  - ON LED on
  - LED on the base unit flashing
  - LED on the MET or MSA module faulty, steadily on
  - the display indicates the type of fault by a code (same as above).
- Special case of faulty DSM303
  - ON LED on
  - LED on the base unit flashing
  - LED on DSM303 steadily on
  - Display off

This Sepam operating mode is also transmitted via the communication link.

RTD Fault

Each temperature monitoring function, when activated, detects whether the temperature sensor associated with the MET1482 module is short-circuited or disconnected. When this is the case, the alarm message "RTD FAULT" is generated.

Since this alarm is common to the 8 functions, the identification of the faulty sensor or sensors is obtained by looking up the measured values:
- Measurement displayed "****" if the sensor is short-circuited
  T < -31°F (T < -35° C)
- Measurement displayed "-****" if the sensor is disconnected
  T > +401° F (T > +205° C)

Replacement and Repair

When Sepam or a module is considered to be faulty, have it replaced by a new product or module, since the components cannot be repaired.

⚠ CAUTION

HAZARD OF DAMAGE TO SEPAM
- Do not open the Sepam base unit.
- Do not attempt to repair any components in the Sepam range, either in the base unit or an accessory.

Failure to follow these instructions can cause equipment damage.

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Schneider Electric USA
295 Tech Park Drive, Suite 100
LaVergne, TN 37086
Tel : 1-888-SquareD (1-888-778-2733)
www.us.squared.com

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